YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

QRP Quarterly

Volume 51 Number 4
Fall 2010

Journal of the QRP Amateur Radio Club International

- WJ2V Reviews the Flex 1500 HF-6M QRP Radio
- An Interview with KX9X: Operating QRP at W1AW in ARRL Sweekstakes
- Two More Projects from the FDIM 72-Part Challenge
- VE7GTU Provides Lessons on Using Gel Cells
- Contest Results—
  - Hootowl Sprint
  - milliWatt Field Day
  - Summer Homebrew Sprint
  - Silent Key Memorial Sprint

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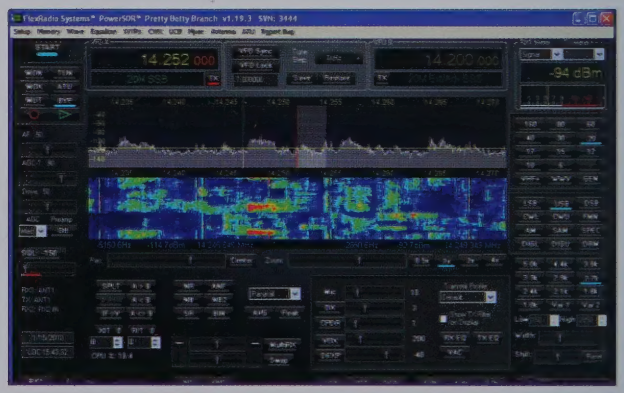

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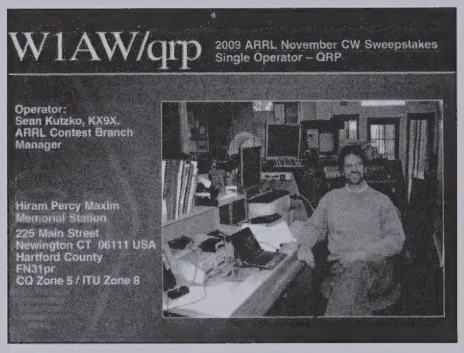

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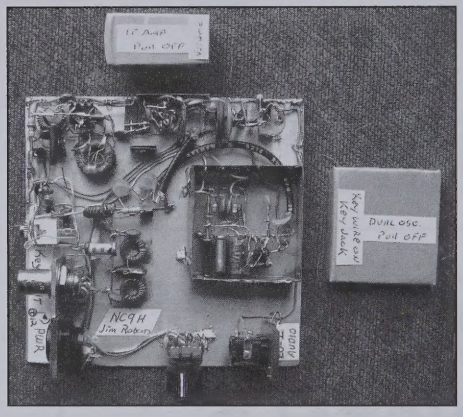

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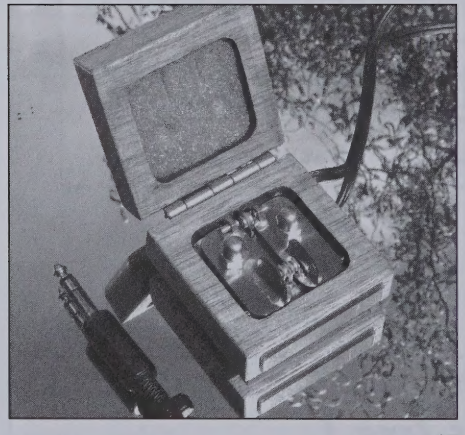

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— On the Cover —

This issue's cover features two QRP kits—on the top is a 75- meter AM rig, the "Retro 75" from Small Wonder Labs (noted in WB9NLZ's QRP Clubhouse column, pg. 4); and on the bottom is a "DDS Development Kit" from Kits and Parts (reviewed by WA5BDU, pg. 45).

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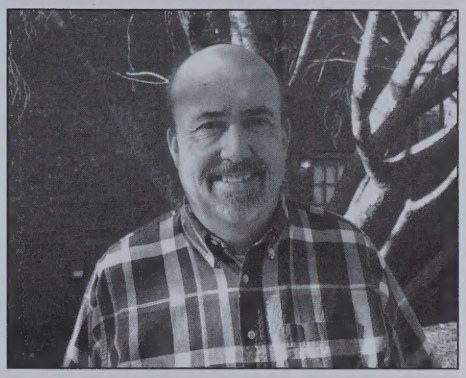


The value of any organization is only as good as the products and services that it provides. The all volunteer staff of QRP ARCI works hard to insure that the dues you pay provide an informative and enjoyable magazine, awards program, contests as well as promoting QRP at hamfests and on the web. I think the staff does an outstanding job! Dues were last changed with the winter 2006 issue. Since then this has meant an annual dues fee of $20.00 per year in the U.S. and $23.00 per year elsewhere. In that five year period, the club has absorbed operating cost increases for various club programs and administrative fees totaling $1.70/year/member. Recently, our publisher (Summit Technical Media) informed us that the production cost to layout, print and mail the four issues of the *QQ* would increase from $15.00 per year to $17.00 per year. This coupled with other increases over the five years means that we need to either raise the dues or cut services. In response to this, the Board of Directors has voted to raise the dues to $25.00 per year in the U.S. and $28.00 per year elsewhere. A flat $5.00 per year increase that is effective with receipt of the Fall 2010 *QQ*. The following is intended to help you to understand this increase:

In 2006, your $20.00 was broken out as follows:

- $15.00 to pay for assembling and mailing four issues of the QQ
- $1.20 Hamfest fees
- $0.94 Toy Store
- $0.48 Travel — Officers represent club at hamfests, etc.
- $0.54 Awards Program
- $0.52 Contests
- $1.32 Administrative & Legal fees

Total cost/year was $20.00 in 2006.

Effective with the Winter 2011 issue the production and operating cost break down as follows:

- $17.00 to pay for assembling and mailing four issues of the *QQ*
- $1.75 Hamfest Fees
- $0.65 Toy Store
- $1.25 Travel — Officers represent club at hamfests, etc.
- $0.65 Awards Program
- $0.65 Contests
- $1.75 Adminstrative & Legal fees

Total cost/year will be $23.70 effective winter 2011 issue.

These numbers show that without a dues change, the club would be losing $3.70 per year per member. With the change, the club will be $1.30 per year above costs. The plan is to use this $1.30 to absorb future increases and help maintain price stability for five or more years.

Two other items to note are:

1. The annual Four Days In May (FDIM) event in Dayton is self funding. Monies from club dues are not used to finance this event. It is financed by seminar and banquet fees and the raffle.

2. Members outside of the United States are charged $3.00 a year more than U.S. members to offset the additional cost of postage.

This increase goes into effect with receipt of this issue (Fall 2010). I hope the data presented helps you understand the need for a price increase. I am sure you will continue to enjoy the *QQ* and the club programs and services.

—Ken Evans, W4DU
President, QRP ARCI

●●

QRP Clubhouse

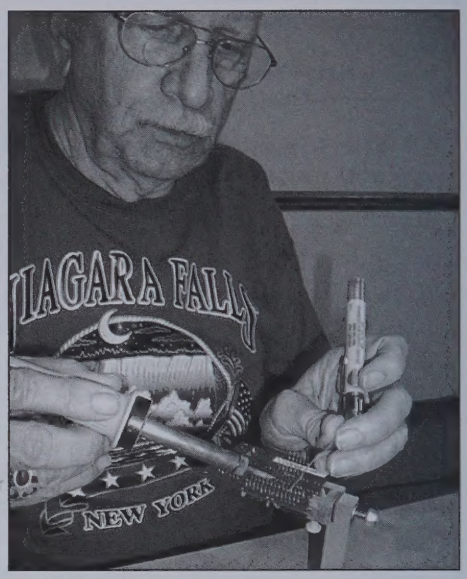
Timothy Stabler—WB9NLZ wb9nlz@yahoo.com

When I realized it was time for my next column, there was a slight problem of what to write about. I figured everybody was doing their summer thing and perhaps clubs were too busy to write anything for me to use in this column. Then, out of the blue, information started coming in.

Right now, the XYL and I are in the final paperwork for the sale of our old home. With the economy, it did take us 15 months. I also find myself working on a project which is the building of the radiotelescope from the June, 2009, issue of *QST*, by Mark Spencer, WA8SME. I have contacted him and he has been very helpful in getting me started, including a CD.

In the last issue, a listing of QRP Clubs in the US and Canada was published. I know there are many other clubs in various countries and would like to make a more complete listing. Below, I have some information from England and Russia. Can you help me out and get me further information on other QRP groups out there?

Darrel KØAWB and his prize



Adding the socket to a cap tester.

Midwest HomeBrewers and QRP Group

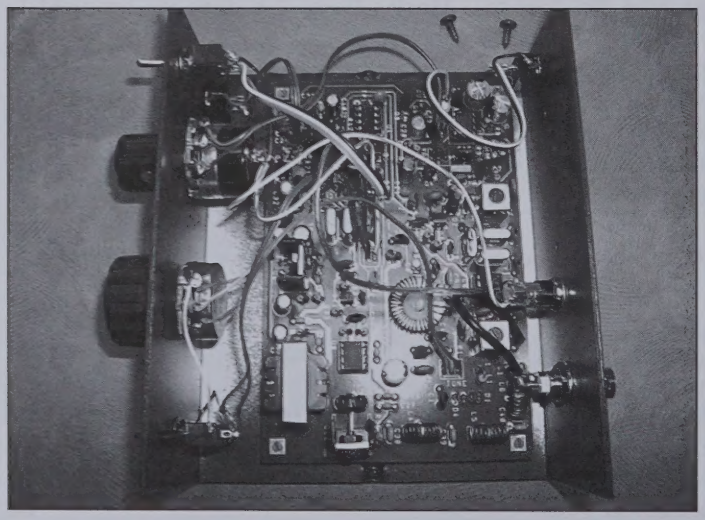
The August get together for the Midwest HomeBrewers and QRP group went off as scheduled on Saturday the 14th. Meetings are the second Saturday of each month unless posted otherwise on the web site. Darwin Piatt, W9HZC, was there working on and finishing his capacitor checker and also working on a little 6 LED blinker. Both units seemed to work. Ray McNally, N5SEZ, also working on a couple things. Arnie Grubbs, KAØNCR, was working on one of his projects as was Joe Eisenberg, KØNEB. Both Darrel Swenson, KØAWB, and Christina Norris, NØRIS, showed up late, but at least they showed up!

Several discussions went on about several subjects. Projects for 2011 OzarkCon were discussed and it was decided to schedule another "Lark in the Park" for the September meeting. The "Lark in the Park" is when everybody meets as normal at the Pizza place, have a quick bite, then adjourn to the Ashland Park and have a mini-field day. Normally 8 to 10 stations on the air around 1200 central time.

Darwin Piatt, W9HZC, gave his LobsterCon report. It was a fun event and the Lobster was delicious. He plans to do it again next year. Pictures will be posted on the HBQRP web site soon.

The Homwbrewer web site (www.hbqrp.org) has been updated and has current information.

The group is always on the lookout for neat circuits to use for group builds. If you have a good little project, just let the group know so they can work it all out.



75 Meter AM anyone?

Joe KØNEB blows a little hot air on the SDR kit he's building.

Midwest HomeBrewers OzarkCon 2010 group. Bottom row—KMØY, KØAWB, WBØQQT; center row—KGØRD, W9HXC, KØNEB; top row—KAØNCR, N5SEZ.

Central Florida QRP Group

As I was going over my final draft of this column, I received information on the Central Florida QRP group, from Kelly McClelland, K4UPG. This a fledgling group of QRP ops that gather monthly for some show and tell and portable ops. In July, 2009, they held a "Gatorcon." Even with only two weeks notice, they still had 17 people show up. In April, 2010, Wally Crew, KG4LAL, Kelly McClelland, K4UPG and Jim Diggs, K4AHO, went to Hontoon Island for activation.

I have added them to the club listing published in the last issue and have been told to expect articles and pictures from time to time. I was glad to hear of this new group and look forward to their input. Their website is: http://cflqrp.wordpress.com.

Bath Buildathon Crew:

The 2010 Buildathon Contest contest took place between 30 May and 5 June. A total of seven ex-Buildathon Brendon transceivers were known to be active but few logs were submitted. Other homebrew participants used an Epiphyte and one a K2.

The station with most contacts was Wayne Thomas, MØWAY, but he was pipped at the post for first place by Tim Raven, G4ARI, who had one more multiplier. Dave George, MØSXZ, nipped into third place with his first ever go at contesting. Thanks go to Mike Coombs, G3VTO and Lewis Thomas, G4YTN, for their check logs.

Key points from the feedback were, unsurprisingly, that the barefoot Brendon struggles to be heard (those with 5 or 10W of SSB had far more success) and that full size resonant antennas do better than mobile whips or loaded dipoles.

G4ARI wins a £50 voucher to spend at Walford Electronics and contest certificates go to those in first, second and third place. Well done to all who took part and thanks to Walford Electronics for supporting the Buildathon event and the contest.

One member of the Bath group, Steve Hartley, GØFUW, wanted a "rock bound" CW transceiver to take part in QRP-ARCI Pet Rock Celebration sprint on 2 January 2010.

The rig was made up from existing "junk" and ended up being very similar to the Little Mate CW transceiver by Drew Diamond, VK3XU, from his *Radio Projects for the Amateur, Volume 2*. His version is for 40m only.

The oscillator was changed to use a general purpose NPN transistor (like 2N3904) with 3.58 MHz ceramic resonator in place of free running FET VFO (he checked and ceramic resonators are classed as crystals). A red 5 mm LED and 33 pF silver mica cap were used as varicap to give RIT. Two further 2N3904s were used in a doubler circuit with tuned output for 40m. Steve found that the RIT midpoint voltage was not even across the band so ended up with only one direction of offset with 12 V across the varicap for TX, variable 12 to 0 V on RX.

The receiver was a Manhattan-style Sudden as built at 2009 FDIM and G-QRP Rishworth Buildathons. VXO components were removed in favor of the off-board VXO, AF amp was modified as per Little Mate, 12 V DC supply rather than 9 V, no series resistor to supply pin and no feedback components between pins 5 and 8. Steve may add CW filter stage between product detector and AF amp later also may replace single toroid input tuned circuit with double tuned filter, but for a simple circuit it works really well on air.

The transmitter board was built pretty much as per the original Little Mate, less the band-switching components; 2N3866 driver, IFR510 power amp, 2N2905 keying switch. The board will produce 6W but bias was adjusted to a little over 4W to keep it QRP legal.

Transmit/Receive change-over was quite crude with just a simple DPDT switch for DC and antenna. He may go for a semi-break in relay later.

Club "72"

I have no idea how many of you subscribe to the Minimalist_QRP_Transceivers@yahoogroups.com email reflector, but if you do, you have seen the following letter from Russia which I am including here for those who did not see it:

Hello QRPers!

Club "72" welcomes all homebrewers to Buildathon-2010.

All wishing participants are welcome. The purpose of competition is to revive interest and to increase of homebrew equipment prestige. Any homebrew constructions are entries. It may be both itself designed and other known constructions, for example: Micro-80, Pixie-2, MicroScope, The 1st QRP Station, Oner, OneRX, AltAir, Gnat, FETer, Reggie etc. These can be both the transceiver or separately transmitter and receiver.

The main requirements are:

- The transceiver or both TX+RX must include NOT MORE than 4 transis-

Station	Contacts	Points	Bonus Points	Multipliers	Total	Equipment Used
G4ARI	14	370	600	2	1940	K2
MØWAY	36	506	600	1	1106	Brendon+linear
MØSXZ	2	21	0	1	21	Icom IC703
*GØFUW	9	182	200	1	382	Brendon + linear, or FT817
*G3VTO	6	200	300	2	1000	Epiphyte
*G4YTN	1	50	100	0	150	Brendon
*check logs						

Final results of the 2010 Bath Buildathon Contest.

tors or 2 transistors with 1 IC or 3 valves;
- 5 or more QSOs for 10 km or more distance must be logged using your radio;
- Detailed circuit with description, photos, extract from log-book, antennas used description required;
- Constructions which assembled using any produced kits not accepted.

Quantity of any passive components not limited. Also no any limitation for used power supply, antennas, frequencies, modes, cabinet design, size, weight.

Send your applications, descriptions and pictures before December 31, 2010 to e-mail: mr7@club72.su. All entities will be exhibit at special "Buildathon" page.

A prize for winner and memory certificate for all masters are guaranteed.

Good luck in your homebrewing art!

—RV3GM, Oleg "Mr 72"

Pacific Northwest QRP Group

The Pacific Northwest QRP Group (pQRP) has a membership of 200+ radio amateurs scattered throughout the Northwest, Alaska and Hawaii. The organization, like many QRP groups, has no officers, elections, dues, rules, or awards programs. The group gathers on the 4th Wednesday of each month for pie and coffee in Bothell, Washington and supports a yearly gathering on the second weekend of July named Salmoncon.

Although Northwest amateurs interested in QRP activities have had very informal meeting for more than 20 years, the current pQRP group, as currently organized, began in 2005. The first Salmoncon annual event was based on the very successful New England Lobstercon event and focused on social, educational and QRP operating activities. The first four Salmoncon events took place in Deception Pass State Park on the North end of Whidbey Island, WA. This year Salmoncon was moved at Valley Camp, nestled in the foothills of the Cascade Mountains near North Bend, WA.

The monthly pie and coffee meetings (P&C as they are called) are opportunities for members to support one another in the latest group builds. In the past five years, the group has undertaken the following group designs and kits: The PNW-15 CW transceiver; an LC meter; an RF test set, using a DDS chip; Currently, more than 20 members are in some phase of construction of Softrock RX Ensemble running powerSDR or WinradHD software. The Software Defined Radio movement seems to have captured imagination of the pQRP group for now. Next up on the group build agenda may be a "USB widget" universal interface device.

Current P&C meetings are focusing on hardware and software issues revolving around this building project. Outside the P&C meeting, the group communicates using yahoo groups as pQRP. Information and photographs of builds are located on the Yahoo groups. The pQRP group has a Monday evenings CW SKED on 80M. Membership to the PNW QRP Group and they have a Yahoo groups reflector that is open to all.

Salmoncon V

Judging from all the feedback received, the PNW QRP group Salmoncon V gathering at Valley Camp in North Bend, WA was a rousing success. The group experienced a serious upgrade in facilities and weather from the seaside Deception Pass State Park facility. The camp is run by radio amateurs! The facilities included a tower with tri-bander and tall trees with pulleys and cables included. The group enjoyed a covered outdoor meeting place with a full kitchen. Campsites included facilities for trailers and tents. Although located in a "bowl" relative to surrounding terrain, which limited VHF operations, the facilities provided a full wave 80m wire loop antenna and the beam provided for plenty of excitement on 20m during this 2nd weekend of July.

The educational component of the gathering centered around seven presentations. The presentations covered the following subjects:

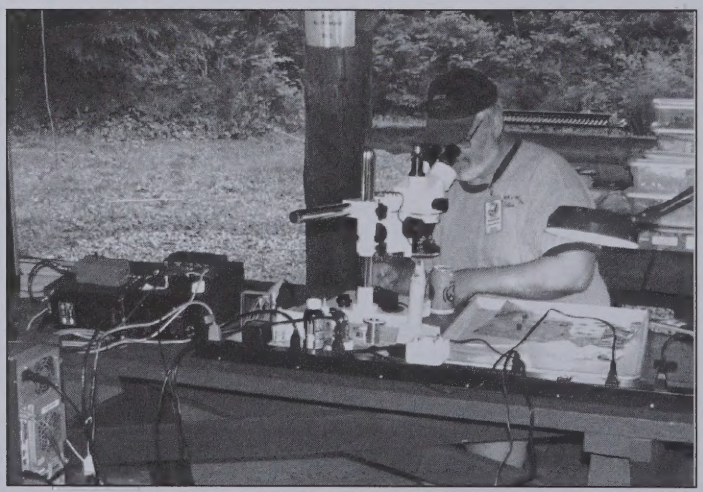
1. Bruce Prior, N7RR, discussed the evolution of the American Morse Code and hardware which was used.

2. Rich Heineck, AC7MA, talked about the evolution of the PNW QRP Test Set

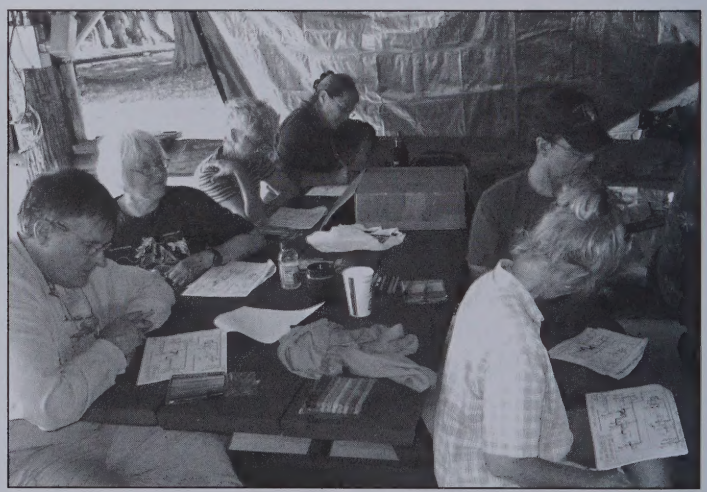
3. Roger Streyart, K7RXV, discussed the function and practical applications of Vector Network Analyzers

4. Wayne McFee, NB6M prepared a great primer of various aspects of transceiver design and group followed along with a "coloring book" and crayons

5. Roger Steyart and Doug Phillips, K7RXV/W7RDP, explained the pitfalls of winding toroids and provided practical

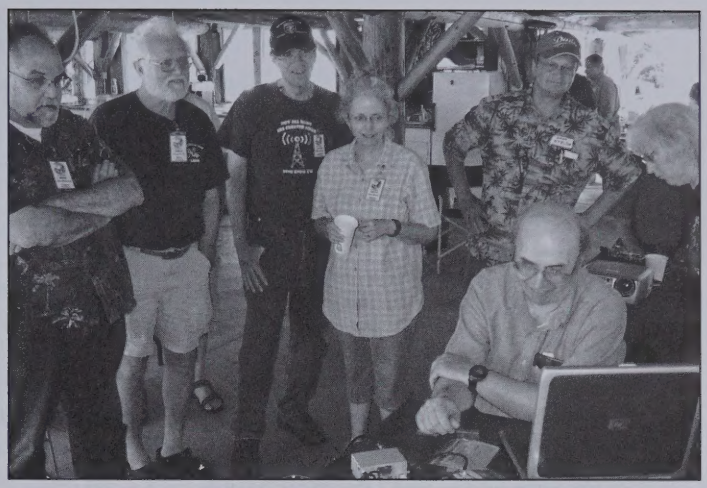


Eldon, WAØUWH, gets down to details with his microscope using SMT technology while constructing a beacon transmitter for 30 meters mounted on the side of a nine volt battery .



Participants trace signal paths in schematics with colored pencils in Wayne, NB6M's presentation "Ham Radio Coloring Book."

Hosts Thom and Teena receive recognition from Wayne, NB6M, for outstanding support to the Pacific Northwest QRP group during Salmoncon V.



Roger, K7RXV, in front of the laptop, checks SWR bandwidth and impedance with a Vector Network Analyzer as group members look on.

examples of how to do it right

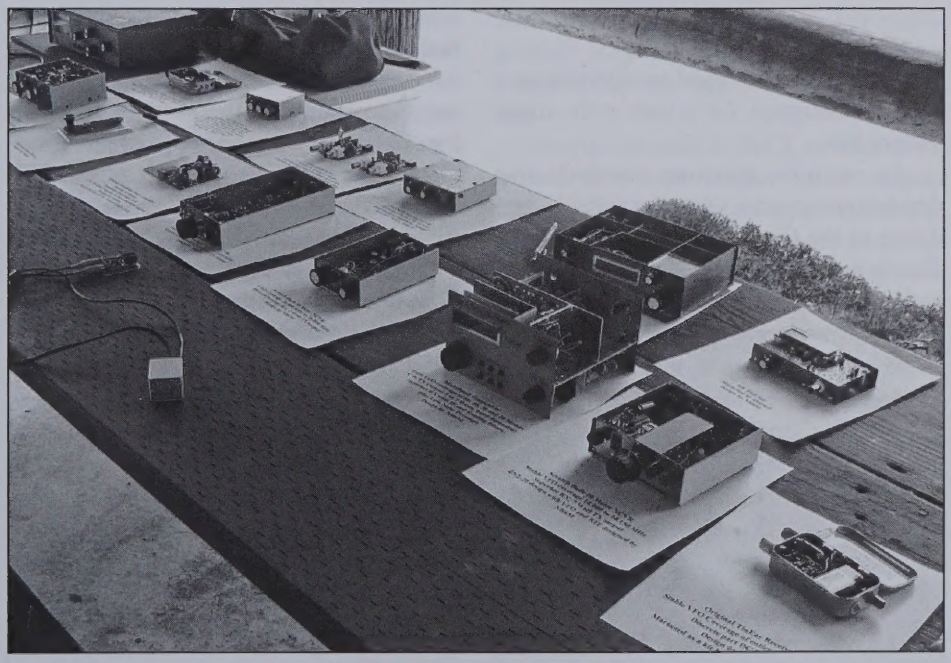
6. Wayne, NB6M discussed the evolution a group project transmitter

7. Lyle Johnson, KK7P, first made a presentation on the Softrock Receiver Ensemble and then one on the possibilities available to the group in the development of a USB widget device.

The presentations were usually attended by about 30 participants. The .ppt slides and audio files of all presentations are available online at: http://www.wx7s.com/drupal/?q=node/21. I found the file on the "coloring book" very interesting and something, perhaps, other groups might use as well.

All Salmoncon participants were encouraged to bring QRP rigs and any other equipment that could be of interest to the group. Two members contributed Elecraft K-3 units to a centrally located operations area near the antenna feed points. The units were always busy during non-presentation periods. Wayne, NB6M set up his large inventory of kits produced during his membership in the Norcal group and pQRP. Eldon, WAØUWH, brought his binocular microscope to the field and demonstrated SMT mounting techniques. Rod, WE7X, despite the poor VHF possibilities, made contacts on 70 cm, 2M, and 6M with omnidirectional loop antennas at 15 feet!. The evening propagation to Europe was outstanding and log showed more than 100 CW and SSB contacts with the Elecraft equipment.

Meals were provided by volunteers from the group. Pancake breakfasts, VLPC (very large pots of chili), and Salmonbergers, provide by Doug, W7RDP, were the meal highlights. The hosts, Thom and Teena, could not have been nicer! They are used to catering to amateur groups and fully participated in our activities. The group unanimously selected these great facilities for Salmoncon VI.



Wayne NB6M's impressive display of homebrew equipment at Salmoncon. Rigs displayed include: 20m and 40m Small Wonder labs units, miniBoots amp, "nuts and bolts 40m," DDS controlled 20 thru 80 CW transceiver, Tin ear altoids 40m rig, HF test set, PNW 15 ugly special, NorCal 38 special, Class E CW XMTR, modified SMK-1 for 20m, and finally an ugly style SMT demo for 40m CW in altoids tin. What a testament to a passion for homebrew equipment!

Guess that is about all I have for this issue. I really need some of you club members to let me know what your group is doing. I hope the Fall is good for everyone. With our old home finally sold, it will be good for me.

—72, Tim Stabler, WB9NLZ

●●

Send news of your QRP or homebrew club's activities to Tim, WB9NLZ at: wb9nlz@yahoo.com

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

Sniffer Fox Hunt Transmitter — N2CX
Never-Soldered Joints Causing Problems
Free Download of Last K4TWJ Book
Powdered Iron Cores and Magnetic Fields
Almost Free Cable Organizers — K8EAB
Blowing Fans with Compressed Air
Easy RF Power Measurement Calculation — K4JPN
Making Your Sinker and Line More Visible — K4UPG
More on Counterfeit Components — WA8MCQ

Sniffer Fox Hunt Transmitter

In the early 1990s, Joe Everhart, N2CX, promised me an endless string of Technical Quickies for my column if I wanted them. Here's Joe's Quickie #75—

Hidden transmitter hunts have always held a fascination for me. Participation was always an adventure regardless of one's success or failure. Even more fun than being a hunter is setting one up. A large issue is always finding a suitable venue and setting the ground rules that strike a mean between being trivially simple or impossibly difficult. Ref 1 outlines equipment and setup for a Scouting related event. Yet another that I set up was the hunt at the Atlanticon QRP event in Baltimore back in 2003 (Ref 2). This Quickie will describe the equipment design and setup for that event.

The Sniffer Fox Hunt made use of the 2003 Atlanticon featured kit, an amplified field strength meter called, naturally enough, the Sniffer. It featured a tunable preselector, a sensitive RF detector and an analog meter for relative signal strength indication. While not as sensitive as a good receiver, it was entirely adequate for locating a nearby low power transmitter. A description and complete manual for the Sniffer can be found at the link in Ref 3. The Sniffer is shown in Figure 1.

The challenge in setting up the Sniffer Fox Hunt was to build transmitters and antennas that put out a large enough signal to be sensed by the Sniffer that were inexpensive and could be deployed unobtrusively in a hotel ballroom. It was decided that simple crystal controlled transmitters with QRPp (less than 1W) would be adequate provided that good enough antennas could be designed. Let's look at the transmitters first.

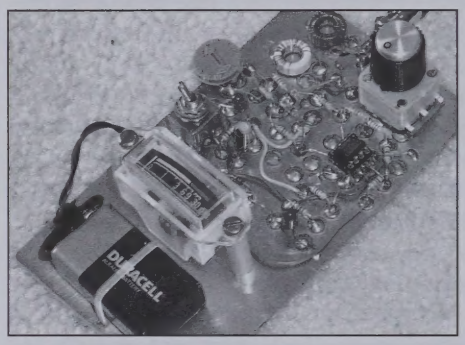


Figure 1—The Atlanticon Sniffer Field Strength Meter.

An extensive literature search (leafing thru ham magazines) found a suitable candidate in the Oner by GM3OXX (Ref 4). This is a rudimentary circuit using mostly junk box parts and requires no tweaking. The name, by the way, came from the creator who built his on a 1-inch square PC board.

Figure 2 is the schematic diagram of the final transmitter. The transmitter proper consists of crystal oscillator Q2 and RF amplifier Q3 keyed by Q1. Quartz crystal X1 sets the operating frequency and a low pass filter consisting of C5, L2 and C6 provide a more or less clean sine wave output.

Two concessions to a non-ideal load have been added to keep Q3 from being zapped. Zener D2 limits the voltage swing on Q3's drain and resistor R6 provides a resistive load in case the antenna is badly detuned or becomes disconnected. With a 9 volt power source and the component values shown, RF output is 100 to 200 mW. To allow practical antenna sizes and available components, transmitters were built for 40, 30 and 20 meters. Figure 3 is a photo of one of the transmitters built so-called Manhattan style.

U1 is a timer connected as an astable multivibrator. It uses different timing values for each frequency band so that the transmitted signals can be uniquely identified. As shown the on/off time is about 0.3, 0.6 and 1.2 seconds for 40, 30 and 20 meters respectively. To be strictly legal the transmitters could have been keyed with an identifying callsign with a microcontroller such as the one described in Ref 5 with suitable timing and callsign changes. Such identification was not used in the Sniffer Fox Hunt since it was expected that

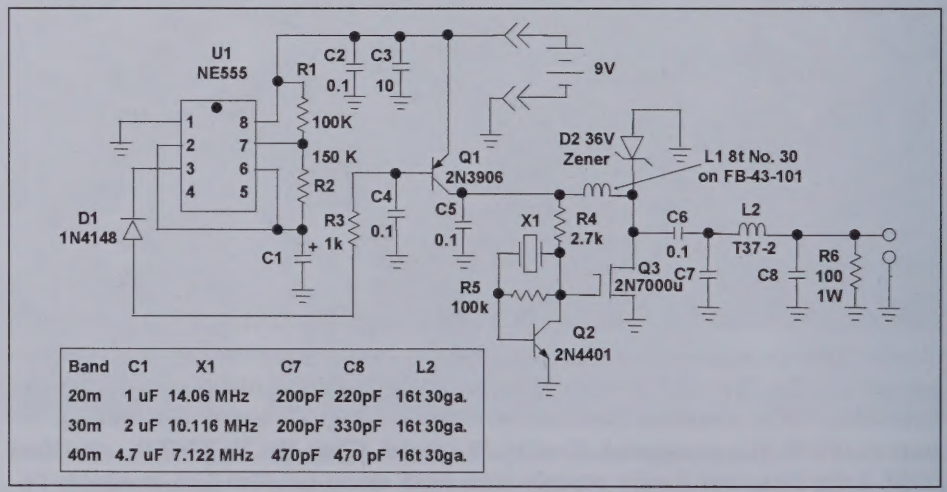


Figure 2—Sniffer fox hunt transmitter schematic diagram.

Figure 3—Sniffer fox hunt transmitter.

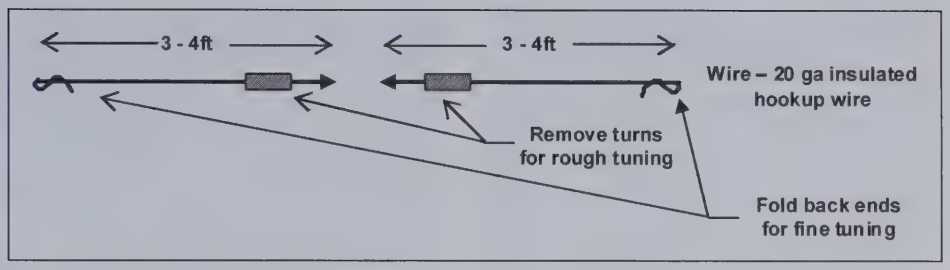


Figure 4—Sniffer fox hunt dipole construction.

absorption by the building and with the antenna configuration used would limit measurable signals to the hotel site. It was determined that using a mobile antenna and good receiver the transmitters were barely detectable just outside the Atlanticon hotel and could not be heard 100 feet farther away.

Coming up with suitable antennas was more of an "interesting" proposition. A test with the 40-meter transmitter breadboard connected to the home dipole antenna showed that the sniffer could detect the signal up to a couple of hundred feet away. This was entirely too strong for an indoor fox hunt. Another trial with a vehicle-mounted Hamstick™ gave over 100 feet of range. On the other hand simply using 5 feet of wire resulted in only 10 or 15 feet of usable signal. A tuned loop of hookup wire about 2 feet in diameter was promising but much too difficult to keep tuned. The best approach seemed to be some sort of reasonably efficient resonant antenna simple and small enough to set up and hide in a typical hotel ballroom.

A 3- or 4-foot wire can be tuned to resonance on any of the bands to be used with a small inductor. Unfortunately such a monopole antenna needs some sort of ground or counterpoise, which would not be available. The next logical thing to try was a small loaded dipole antenna. After a number of trial and error sessions the configuration in Figure 4 seemed to be the most practical. Using this antenna gave a usable range of at least 30-40 feet from the transmitter using the Sniffer as a signal detector. The wire dipole antenna is small enough to deploy clandestinely in a hotel meeting room.

Antenna tune-up was an interesting process in itself. Trying to resonate both halves of a dipole at the same time proved to be a fruitless task so the job was broken into several parts. To begin, each dipole half was resonated against a quarter wave wire using a Micro 908 Antenna Analyzer, although any other such instruments such as those from Autek or MFJ can be used. Then the pairs for each band were used in dipole configuration and final tuning performed.

The tuning inductors used were the Radio Shack 273-102 RF choke. As purchased, they use magnet wire wound on a cylindrical form made of a ferrite material. The stock value is 100 µH, which can be reduced by removing turns. Fine tuning is done by folding back the end of the dipole wires to effectively shorten them. Note that the resonant impedance will likely be above the 50 to 75 ohm value you might normally expect due to added loss resistance in the loading choke. Figure 5 is a photo of half of one of the tuned dipoles. Each of the elements is connected to the transmitter by an alligator clip. For photographic purposes the wire elements are rolled up. In use they would be stretched out.

As you can read in Ref 2, several of the transmitters were hidden under display tables in the ballroom using—what else—duct tape. Yet another was taped to a flagpole and hidden from casual view by carefully draping the flag over it. I highly recommend you check out this humorous report for a flavor of the event's activity.

Pretty much the same equipment can be used for any short range outdoor fox hunt, though it is recommended to use some sort of protective enclosure for the electronics. With good antennas the transmitters will have the same range as any other QRPp rig. Even the inefficient loaded dipoles described herein deployed vertically will likely give good reception by a decent fox hunt receiver well over a mile away.

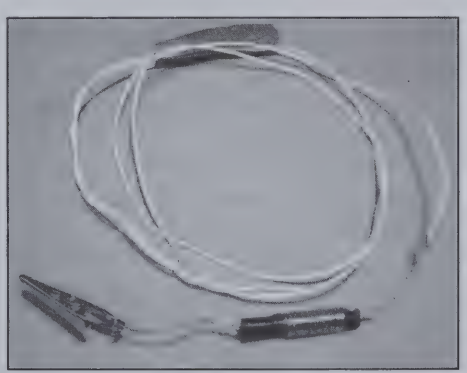


Figure 5—Fox hunt dipole element, 1 of 2.

References

1. Joe's Quickie No. 64 - Good Enough Fox Xmtr, N2CX, included in the WA8MCQ Information Exchange column, *QRP Quarterly*, Winter 2008.

2. Atlanticon 2003 Sniffer Fox Hunt http://www.midnightdesignsolutions.com/atlanticon/atlanticon%202003/Atlanticon2003recap.html#Sniffer%20Fox%20Hunt

3. AMQRP Sniffer (discontinued kit) and link to manual http://www.njqrp.org/sniffer/index.html

4. "Oner Transmitter," George Burt, GM3OXX, *SPRAT* #45Winter 1985/1986 p. 45

5. Joe's Quickie No. 74 — Quickie STL Test, N2CX, included in the WA8MCQ Information Exchange column, *QRP Quarterly*, Fall 2010.

—DE N2CX

Never-Soldered Joints Causing Problems

This discussion thread appeared recently on the HP/Agilent test equipment discussion forum on yahoogroups.com. It's something I've personally experienced over the years a number of times. When troubleshooting something that is dead or intermittent, don't forget to check the solder joints. Just because something has been working for years, and in many cases passed an outgoing inspection by the manufacturer, that doesn't mean that all of the solder joints are good, or that they even all exist.

The thread started off with this post from David Partridge in the UK, with the subject line "Interesting fault in a piece of test gear"—

The patient was a Racal 1998 counter, but the problem could be seen in other equipment too, so it is relevant.

After initial signal conditioning, the input is fed to a fast ECL comparator (AD96687) which is used to "square up" the signal and convert to differential.

The input signal was present at the input to the comparator, but was riding on a DC signal, which started at about +2.5V and slowly drifted down to –5V. The reference pin was correctly sitting at 0V. I chased my tail on this problem for about two hours (feeling more like the fabled oozalum-oozalum bird as each minute passed).

Eventually I reasoned that the 470 ohm resistor shown in the schematic from the input pin to ground should prevent the behavior I was seeing from happening. The chip resistor was there on the underside of the board and actually measured correctly.

However, there was solder on one pad but the other pad was clean as a whistle, and there was no sign of solder on the contact on the chip either. Pressing it gently down onto the pad confirmed the open circuit, and a dab of solder fixed the problem. I've not seen this variation before.

Peter Reilley had this reply—

I have an HP 3582A spectrum analyzer that I got from an equipment dealer who was clearing out his "unrepairable" pile. It had a resistor that had only one side soldered. The board, all thru-hole, has every other solder joint done perfectly. This unit must have worked for 20 years before that one connection wiggled lose.

From Jos Raven, PAØAMX—

I encountered exactly this a few years ago, albeit in the Alpine radio of my 1995 XJ6 Jaguar.

The CD player refused to play sometimes; the in-between-playing periods got longer over time and it finally stopped completely.

There is a handshake between the radio and CD player and in this circuit an SMD resistor had the same fault, one side soldered, the other with not a trace of solder. So that pad made contact, but the contact corroded slowly and resistance built up until the handshake was blocked.

From Craig Sawyers—

I had a real bear of an intermittent fault in a1984 XJ12 (which in restored form I still have). It would just totally cut out. Started out once a year, then became once a month. Finally when it was nearly every day, I decided enough was enough. So one cold October night, having racked my brain on possible causes, I hauled the engine ECU out onto the boot (trunk) floor and took the covers off. With engine running, I prodded and poked each component (no surface mount in them days!). Eventually when I touched a particular capacitor it cut out—perfectly repeatable. Examination under a bright light revealed, under a thick layer of conformal coating, a dry solder joint. Hasn't missed a beat since I re-soldered it.

From Mike Zucker—

I posted this a while back on the Tekscopes forum, but on the chance there is a competition for "longest sleeper"...

My newly repaired Tektronix 316 scope passed test and calibration, but had an odd trouble triggering on low-frequency waveforms. It fired if dV/dt was high, as in a square wave or pulse, but the minimum triggerable sine amplitude strongly depended on frequency; line trigger was sketchy at best. Everything checked out up to the actual Schmitt trigger.

In desperation I went to isolate the halves of the trigger tube. On unsoldering one end of the grid stopper, the other end fell out of the socket lug. Not even tinned, just hanging in air. The few pF of stray capacitance was enough grid coupling to fire it and pass checkout, so long as one used a square wave (which was all they had—someone recently found and posted the internal QA checklist from the factory).

I believe the instrument's been running like that since it left the Tektronix factory in Beaverton in 1958. It triggers a LOT better now.

WA8MCQ: Not being familiar with the term "grid stopper" I asked Mike about it. Here's his reply—

A grid stopper is actually a small resistor (say, 100 ohms in this case) placed in series with a tube grid. The grid looks like ultrahigh impedance, a few pF capacitance in parallel with maybe hundreds of megohms (like a FET gate). So this series R has absolutely no effect at nominal signal frequencies. Rather, it damps HF reactances from the driving circuit. These can lead to positive feedback and attendant HF or VHF oscillations. It's called a "grid stopper" because (at least in theory) it stops the oscillations.

A while later, Jim Cotton, N8QOH, posted this—

I bought a Tek 496 video driver board from a trusted individual that had been factory reworked and had a tag saying that it passed test. I plugged it in and it didn't work. I tapped it with a pencil and it came to life. Several leads were folded over and trimmed, but not soldered.

Finally, Kuba Ober had this to say about surface mount parts with no solder on one end—

This is a common failure mode. What happens is that a hole in the solder paste stencil gets clogged up, and then that pad doesn't get any solder until automated optical inspection (AOI) will eventually trip on it (if that).

WA8MCQ comments (not posted online): As for me, over the years I have seen every different scenario described, and then some.

I do occasional inspection of items with surface mount parts at work, under a microscope. I've seen some occasionally that had zero solder on one end, but I've also seen some where all of the solder paste got deposited in the proper spots but some of it did not wet properly to both pad and component during the reflow process. It just melted on the pad but didn't flow and wet to the part.

The result is that one end would be perfectly soldered while the other end had a nice, well formed solder dome on the pad with the end of the component sitting on top of it, not wetted to the solder at all. In some cases there was no continuity, and in others there was. Those, of course, would probably pass subsequent testing but eventually result in intermittent operation or become completely dead.

Checking solder joints should be one of your troubleshooting techniques when all else fails, or perhaps even be one of the first things to check. (This presumes that you have the capability of doing it, which

in many cases will require magnification of some sort.) And as you can see, nothing is immune; a hand wired chassis can have bad solder joints just like a printed circuit board with either through hole or surface mount components. Humans and machines and processes make mistakes, and inspections and testing don't always catch everything.

Finally, a story that I think I told here a number of years ago but is worth repeating. Quite a few years ago I knew a local ham (now a silent key) who had once worked at the Heathkit store in Baltimore. A woman brought in a kit that her son had assembled but didn't work, and she was rather upset. He took it back into the shop to take a look at it and returned a few minutes later. Although it was well done, all parts in the proper place, neatly installed and with excess lead lengths cut off, there was absolutely no solder whatsoever, anywhere. He pointed out that of course it wouldn't work like that. She replied that her son was only 10 years old and she wasn't about to let him anywhere near a hot soldering iron!

Free Download of Last K4TWJ Book

Dave Ingram, K4TWJ, became a silent key recently. He was the former QRP editor for *CQ* magazine, and for more years than I can count he wrote about various aspects of QRP. One of his passions was CW keys. He wrote several books on that subject, and his latest is available online as a free download. You can find it at:

http://www.k4twj.com/books.htm

Two versions are available. If you have a high speed Internet connection you can download the full resolution version, and if you have a slower connection there is a lower resolution version that won't take as long.

Powdered Iron Cores and Magnetic Fields

Here's a bit of info that's good to keep in the back of your mind. Mike Blake, K9JRI, posted this recently on the QRP-TECH forum on Yahoo.com:

I hate to admit this but I did not know that powdered iron cores were sensitive to magnetic fields. I had noticed that whenever I placed my NADC-40, BitX20A or Retro-75 on top of my Astron RS-7A power supply I would have hum in the receiver's audio but no hum from the PFR-3A or the PSK-20.

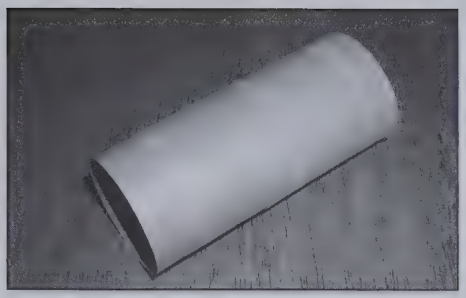


Figure 6—Behold, the lowly toilet paper roll core. A throw-away item? Not if you know how to utilize it.

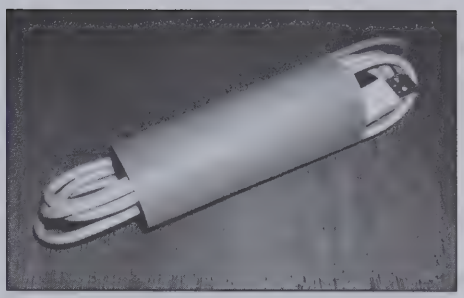


Figure 7—The recycled core becomes a cable organizer.

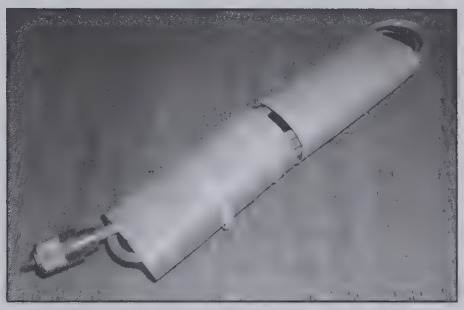


Figure 8—For longer cables, use more than one core if necessary.

I was kind of mystified with this hum as there are no audio transformers in these rigs to pick up the AC field from the Astron.

This evening I was listening to a QSO on 7.030 MHz using the NADC-40, and I moved my small loudspeaker from wherever it was to the top cover of the rig. The pitch of the signal changed a small amount. So I went to my shop and brought back a fairly large ceramic magnet and passed it over the top of the NADC-40 and the frequency changed dramatically.

As these three rigs all have powdered iron core based VFOs and the rigs that are not similarly affected all have either DDS or crystal controlled receivers, I finally figured it out.

Why didn't anyone tell me???

Nick Kennedy, WA5BDU, made this comment—

I remember the manual for a Triton II transceiver I bought in 1979 saying that users operating mobile might hear a bit of frequency shift each time the car passed over a joint in concrete highway slabs. Their explanation was that steel in the joint focused the earth's magnetic field and affected the VFO coils in the transceiver.

WA8MCQ comments (not posted online): I was aware of magnetic fields affecting powdered iron cores in the dim past but had long since forgotten about it, and it's a good thing to know.

This could explain some posts I've seen on various online forums over the years where people had hum when using homebrew rigs that disappeared when they took them off power supplies and used batteries instead. In the process of changing power sources, the rig and power supply may well have ended up farther apart from each other, or perhaps the supply was turned off. Either way, battery operation might not have been necessary after all.

There are many sources of magnetic fields around us, such as transformers, motors, speakers, etc. Keep this in mind if you see some strange operation from your small rigs; that could be the cause.

Almost Free Cable Organizers

This was sent in by Weymouth Walker, K8EAB, a member of the Northern Georgia QRP group.

Although I'm not the proverbial "cheap ham," this idea appeals even to me. We all have experienced tangles of cables and cords of all description around our shacks; AC power cords, USB cables, 12 VDC rig power cables, short coax cables, bungee cords, etc. Wrapping these cords or cables with electrical tape is inconvenient and sticky, rubber bands break, wire tie-wraps get lost; I needed a reliable solution.

I hit on this idea some time ago, and have been accumulating the cores from a universally used household product. The supply is endless and the cost of this application is almost zero. Figure 6 shows the raw material.

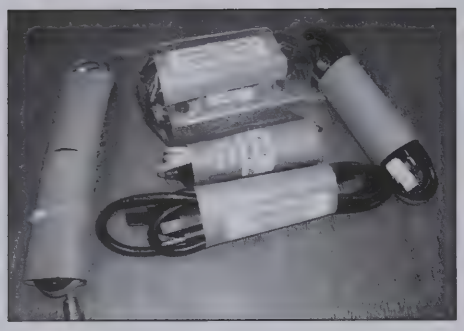


Figure 9—Labeled and wrapped with tape for strength, the cores make for neat cable storage.

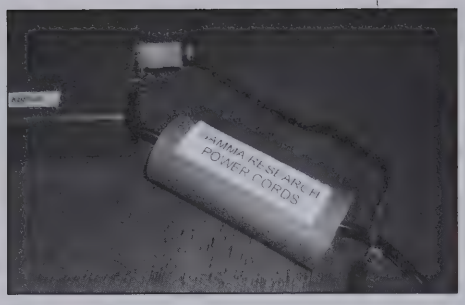


Figure 10—Insert the cable that came out of the core back through the core so as not to lose it while using the equipment .

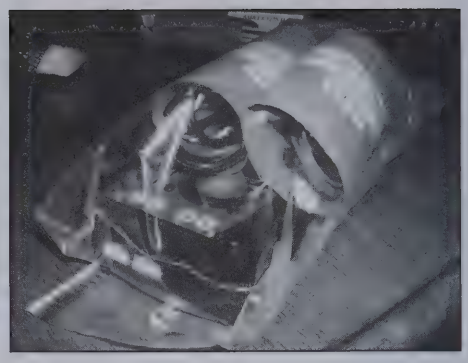


Figure 11—Zip-Loc bags make packing for trips easier, neater and drier.

Figure 7 shows it in use. This expended core can be used to hold just about any cable or cord in a ham's shack. For longer cables, two cores can be used (Figure 8) or a single core from a roll of paper towels.

The core can be labeled with a Sharpie marker or with a printed label as shown in Figure 9. For extra strength, the core can be wrapped with clear shipping tape. Cables for various pieces of ham equipment or dedicated uses can be kept together in a compact, readily storable and readily identifiable manner

To avoid misplacing the cardboard core while using the cables that were stored in it, simply run one of the cables through the core (Figure 10).

Packing for ham radio trips or expeditions becomes more organized and lends itself to moisture protection if the cores are inserted into Zip-Loc plastic bags, shown in Figure 11.

WA8MCQ comment—Not included in his submission but appearing in his online photo storage area, Figure 12 shows another type of core that is useful for smaller cables. This one won't be as common as the larger cores since it comes from the roll of labels that he used to mark them. It appears to be from a small desktop label printer such as the Dymo LabelWriter that we use a lot at work. The core on these is 1" diameter and thicker and sturdier than the other cores. Take a look around at home and work; anything that comes in a roll and has a cardboard core is useful. Possibilities for larger, heavier cables are cores from rolls of packing tape and duct tape.)

Uses for this idea are limited only by the user's imagination.

—DE K8EAB

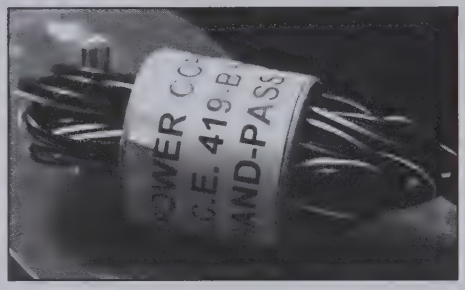


Figure 12—The expended core from the printed labels is also useable, for smaller 12 VDC power cords.

Note—At time of writing, the photos could be viewed online at:

http://picasaweb.google.com/weymouth67/HelpForHams#

Blowing Fans with Compressed Air

The short answer is: Don't do it.

A discussion on the TekScopes online discussion forum (Yahoo.com) started out talking about cleaning printed circuit boards and drying them off with compressed air, or blowing off dry dust with it, which prompted the following comments.

From Scott Singelyn, N8ZPJ—

A word of caution regarding compressed air. Be careful around fans (small muffin types) while drying/dusting things with compressed air.

While I was dusting out a PC with compressed air, I very briefly hit the fan with the air stream. This caused the fan to spin up so fast that it threw out the motor windings from the centrifugal force, thus seizing the fan, and causing me to replace it. Honest, I only hit the fan for about 1 second. It made a cool siren noise, and then stopped moving.

Lesson learned; now I always immobilize the fan with a cotton-swab (Q-tip) or small screwdriver in the blades to prevent it from spinning, just in case it gets hit with the air.

From Mac Perkins—

Spinning up a DC fan with compressed air also makes it a remarkably good generator, whose output voltage can easily exceed its normal supply voltage, damaging either its internal driver circuitry, or if you're really unlucky, other components that share the same power rail.

We had a series of mysterious failures on rental units that were routinely blown out with air on return. The rental warehouse staff liked to see how high a pitch they could create by spinning up the fans with shop air. I did a little testing and found the 12 V rail was around 20 V when this was done, with the rest of the circuitry unpowered, leading to failures of several power drivers.

We required that the fan be immobilized before blowing down the units, and the failures stopped. A small screwdriver through the fan works well and is difficult to miss; we tried toothpicks, but they did not always get removed.

WA8MCQ comment: I'm guilty of doing this myself a few times over the years. I never suffered any failures that I'm aware of, but I was lucky and will never do it again!

Easy RF Power Measurement Calculation

Steve Ray, K4JPN, passed this along by e-mail—

I really enjoyed the AB40J article in the Winter *QQ* "Idea Exchange," an excel-

lent article showing how RMS voltage works. It made me think of an old trick to calculate RF power with a scope. A simple formula to use is 1/2 the peak to peak voltage squared and divided by 100.

$$P = \frac{(1/2\ Vpp)^2}{100}$$

The neat part about this trick is that one can easily measure half the peak voltage on a scope and square it, and then it is simple to divide by 100, by simply moving the decimal point two places to the left. If one uses the peak to peak voltage one must calculate the RMS voltage, then square it and divide by 50.

Realize this is only exactly accurate for a 50 ohm dummy load. However, a dummy load of 48 to 52 ohms will still make the calculation very close.

AB4OJ shows this in his calculations for a diode probe. Just thought I would point this trick out for use with a scope.

WA8MCQ comments: And measuring one half the peak to peak voltage is easy on a scope if the signal is symmetrical above and below the 0 volt line. You don't have to measure peak to peak and divide by two. Just remove the input, or move the input switch on the scope to ground if it has one, then adjust the vertical position knob until the 0 volt reference point is at the bottom of the display. Everything above that will be one half the peak to peak voltage (presuming you have a good, symmetrical sine wave).

—DE K4JPN

Making Your Sinker and Line More Visible

Launching fishing line into trees is a common way to raise antennas, but you have to be able to find the other end when it comes down, and that can sometimes be a problem. Someone on the 4SQRP online forum (Four States QRP group) said he paints his weights (lead sinkers) orange, but they are still hard to find. Kelly McClelland, K4UPG, replied with this—

I, too, have had problems tracking my sinkers, but stumbled on a bit of a solution. I tie a 2- or 3-inch piece of bright orange plastic surveyor's tape to the sinker (Lowe's or Home Depot have rolls of it). The tape is not sticky and is very thin; it does not seem to affect the flight of the sinker at all. I use small swivel snaps on the fishing line, and put the tape on the snap. The tape offers enough visibility to make it easier to see where the sinker and line end up whether it is up in the air or on the ground.

I also switched to using the bright red Cajun brand of fishing line as it is also easier to see against the background of the trees and seems to be a bit tougher than the clear monofilament line that came on the reel I bought for my launcher.

WA8MCQ note—The four states the club is named for are Kansas, Missouri, Oklahoma and Arkansas.

—DE K4UPG

More on Counterfeit Components

When we buy components from major supply houses like Mouser, DigiKey, etc., they are virtually always good parts. And when the rare bad item slips through they will quickly replace it. We also buy from other places such as hamfests, dealer Web sites and online auction sites such as eBay. Although the vast majority of those also have good components, there are some parts out there that aren't so good. Although not mentioned much in ham radio circles, counterfeit parts have been around for quite a few years and are a problem in the commercial world.

As always, when dealing with a vendor you are not familiar with, it would be prudent to exercise a bit of caution. Most likely you will have good results, but there is always the possibility of getting stuck with counterfeit or otherwise defective components. (Although the examples mentioned here are transistors, just about any component can be counterfeited. And while just one country is mentioned, counterfeit components can be made anywhere in the world.)

Back in 2008 I ran an item from YO8CAN warning that some 2SC1969 or 2SC2166 transistors might be counterfeit, and relating his experience with some that were. (He said, in part, that they "are 'lazy' at RF; they do not operate much above 7 MHz. Last year I bought many cheap 2SC2166 transistors. I tested and found that I could not use them above 3.5 to 7 MHz. The gain drops dramatically when increasing the frequency, becoming near zero above 10 MHz or so.")

Ken Greenough, G8BEQ, posted his own experiences recently on the GQRP forum on Yahoo.com, with the subject line "Fake transistors from China"—

There's a mention in *Sprat* [journal of the GQRP club] of fake 2SC1969 transistors being supplied from China. This warning should also apply to 2SC1972 transistors and likely more, of course. I've just replaced some 2SC1972 drivers in an Icom IC756PRO (due to the owner's switched mode power supply putting 26 volts into the set). They were just a few pence short of a hundred British pounds from Icom UK (frightening), and they went again after a short while (and, yes, I did set the bias correctly).

Looking for a cheaper solution I came across a seller in Hong Kong at a very, very much lower price, so cheap that I thought it worth the risk. Well, they came very promptly indeed (by airmail), but when I checked them it turns out that the center lead is the collector (and the tab), and it should be the emitter.

They are marked up as 2SC1972 and have the Mitsubishi logo. I contacted the supplier, and he says it's a mistake (I'll bet!) and he will send replacements. I'll have to see if this is true, but the point of this mail is to warn anyone tempted by these cheap deals to check what they receive before putting them into a circuit.

It's a shame that the genuine parts are so ridiculously expensive from the set makers.

—DE G8BEQ

When I mentioned the subject to editor KB9BVN, Brian said, "I bought a half dozen 2SC2166s off a guy on eBay a year or so ago. They were absolute junk. I got digging into the origin and found they were some Chinese fakes. Honked me off, and of course the vendor was long gone."

I asked Joe Everhart, N2CX, if he had an incident he could tell me off the top of his head and this is it—

The only counterfeit story I have to tell is purchasing some really cheap IRF510 FETs some years back from an offshore source listed on the popular auction site. I did not check them on receipt, but they were more or less marked as International Rectifier components. Several months later when I tried to use them in an RF power amp they drew power but put out no RF.

A quick ohmmeter check showed that several out of a lot of 10 or so had blown

gates. Tests at work with decent test equipment showed inter-element capacitance several times that of good IRF 510s (I had several known good ones for comparison). DC checks proved that they had almost no gain even at DC. My suspicion is that wherever they were manufactured, the assembler used unknown floor-sweeping chips and just packaged them and marked them regardless of characteristics.

Caveat emptor, as always, and beware of sloppy markings that deviate from standard logos, etc. I suppose that the original source figured that for cheap devices no one would have enough incentive to do anything but just pitch them and not seek recourse.

—N2CX

Although some counterfeits are relatively expensive components, such as fancy digital chips costing tens of dollars each or more, inexpensive items are obviously counterfeited as well (and not necessarily semiconductors). Although the profit margin per piece won't be as great, they can make it up in volume.

One of the classic warning signs that something might be counterfeit is when something is in great demand with long lead times from reputable vendors but suddenly appears in significant quantities from a vendor no one has heard of before. And often the prices will be as good or better. (Although there's a good chance these are counterfeits, another possibility is that they might be rejects from the Quality Control process. I've read stories over the years about unscrupulous employees retrieving rejects from dumpsters and selling them as new components.)

As I said in 2008, you might see warnings about counterfeits on manufacturer Web sites, and I mentioned Micrometals, maker of powdered iron toroids, and Mini-Circuits. I later noticed a statement on the Web page of Coilcraft, a well known inductor manufacturer. They have their own sales offices and representatives, but it says, "We do not sell through distributors or brokers. Coilcraft parts they may offer are previously owned, non-RoHS or counterfeit."

That can be the case with just about anything bought through unofficial sources. Although all of them are important for a company buying components, as homebrewers we often don't care if things

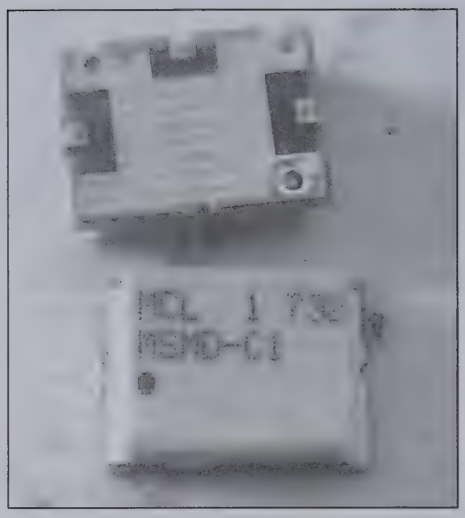


Figure 13—This is one of the "fake" mixers I received, just as shown in the eBay picture. It turned out to be a legitimate product.

were previously owned (think "surplus") or are non-ROHS (not lead free) as long as prices are good and the parts are good. But being counterfeit is usually a bad thing because quality frequently suffers.

While some things may be harder to get the regular way, and not at bargain prices, it's usually a safe bet to get them from reputable, well-known vendors or distributors, or someone else that you trust. Your chances of getting genuine products will be much better, and the source will still be there and be responsive and supportive if you have a problem.

Although I'm sure this is extremely rare, there can even be cases in which something that appears to be obviously fake is actually legitimate. A few times over the years I've picked up things from various sources that didn't appear to be legitimate parts of a manufacturer's product line and yet turned out to be quite above board. They had been special orders or custom parts, sometimes a long since discontinued product.

My most memorable experience with a non-fake fake is the lot of Synergy Microwave mixers I saw listed on eBay a couple of years ago at a very good price. No one else would touch it with a 10-foot pole, and I got it for the minimum bid; I was the only one willing to gamble on it, and Figure 13 shows why. (I was willing to risk it since I had already dealt with the vendor several times and never had a problem with him.) Although the title of the auction said they were Synergy Microwave mixers, the photo showed something clearly marked as a Mini Circuits part. Not only that, the part number, MSMD-C1, did not appear in the Mini-Circuit listings, and there was nothing close to it.

Synergy does have a very similar model number, SMD-C1, and the package style is the same, which is probably why the seller used that name. I tested one and found that it worked well. I popped another open and found the construction quality was what I would expect from Mini-Circuits, not a cheaply made rip-off, so I contacted them. (Remember, Mini-Circuits has a note on their Web page cautioning about counterfeits.) They told me that yes, it was indeed a Mini-Circuits product made many years ago, the result of a custom order. Since there was no further demand for it they eventually stopped offering it.

While trading e-mail with N2CX I remarked that this discussion of counterfeits would be presented as a cautionary tale, and not that "the sky is falling!" because there are still a lot of good parts out there on the "unofficial" market; we just have to be careful.

Joe replied—"Yes, the tale should be carefully cautionary. The instance of the bogus IRF510s represents a small subset of cheap parts I've bought that were both fully functioning and cheap. The best bet is to buy either from someone you have history with or someone who has had a good reputation with others. On the other hand, how do you tell if a new or unfamiliar supplier is on the up-and-up without trying them?"

As always, the bottom line is caveat emptor. I'm not about to stop buying things from various surplus sources, hamfest dealers, eBay, etc., and neither should you. Just be aware that counterfeit components do exist and act accordingly.

—DE WA8MCQ

The Fine Print

You know the drill—send your info to Severn any way you can get it here (e-mail, snail mail, floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet. We take care of the rest, editing, redrawing, etc. The readers are waiting!

■■

Up a Creek Without a Maddle

John Pawlicki—K8AG

bigjp@comcast.net

Some creative home brewing can turn an old computer mouse into a very usable set of iambic CW paddles.

The opportunity was that my latest QRP kit requires a dash dot type of paddle, rather than a straight key, to use all of its functions. I own a very nice set of paddles for my home station, but its big, heavy, delicate and expensive. I needed a replacement, but preferably something smaller, lighter, rugged and cheap. I puttered around with various ideas involving available hardware. Feeling home brew was called for here, I spent a long time searching the Internet for ideas, sketching and trying things. Usually the things got big, heavy and expensive quickly. None of them ever got to the delicate/rugged stage of development.

I have been involved in computers longer than most. Before keyboards and video screens, every new gadget first seemed unnecessary. Most new devices ended in the trash heap (i.e., basement, garage). Some devices, however, started strong and still remain a part of everyday computer use. No device is more this way than the computer mouse.

No, I'm not going to go back and discuss where the mouse was invented and who first marketed a mouse as a computer input device. That information is all available on the Internet for those who care to look. I am talking about all of those old, scruffy, odd looking and nonworking mice that have accumulated, especially since the newer wireless, optical mice have come to market. These old veterans of computer geekdom can be repurposed. These mice, especially the older, ball type mice, with two buttons, wires and hopefully no scroll wheel, can be turned into a handy set of paddles with just a bit of home brew ingenuity.

First, we need to get a mouse. A single ham swap and call out to the extended family resulted in a virtual horde of abandoned mice. Will the conversion work? Most likely, yes. But it may take some effort. The kind of mouse to look for is wire connected (USB, PS2 or RSs-232 will do). It needs at least two buttons (sorry Apple fans). We all remember fighting to clean the ball and the sensors and hopefully we could get the mouse to work to finish that paper or project. Mice with a rolling ball are probably the easiest to find as the new optical mice work so well that many ball mice have been replaced. If you don't have one of these old clunkers (you must be quite young), then go to ham swaps, garage sales, flea markets and even the Internet. Pick one with the fastest and easiest buttons. Optical mice may work as well, but I have yet to try one. The switches are the most important part.

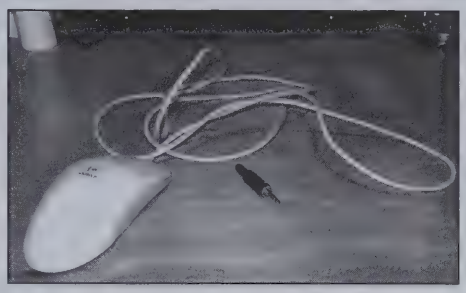


Figure 1— With an old computer mouse, a paddle connector, some solder and creative thinking, you can convert the mouse to a handy, light, rugged and portable set of iambic paddles.

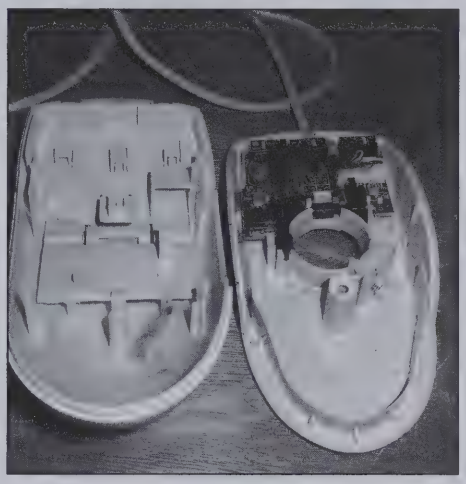


Figure 3—Once pried open you will see the inner workings, and occasionally a dust bunny or two.

Once we have our candidate mouse, we need to disassemble the thing. This is the part that gets a bit ill defined. Mice have been made by hundreds of companies in thousands of models from everywhere on the planet. We don't care, except that we need to find out how to take it apart.

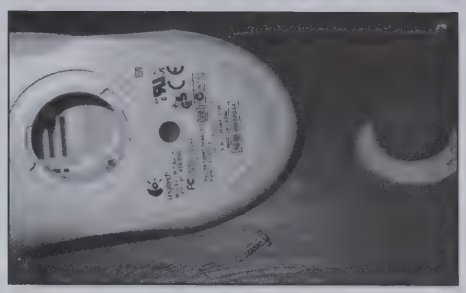


Figure 2—Disassembly is usually done with removal of the ball and one or more screws. Careful prying may also be necessary.

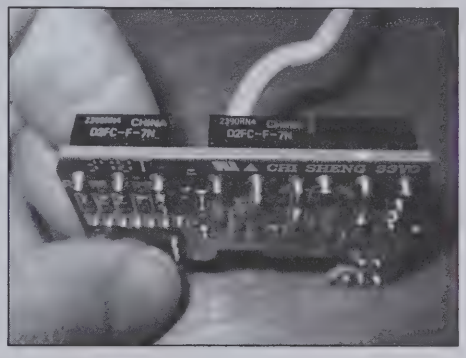


Figure 4—The button switches are mounted to and connect through the small pc board.

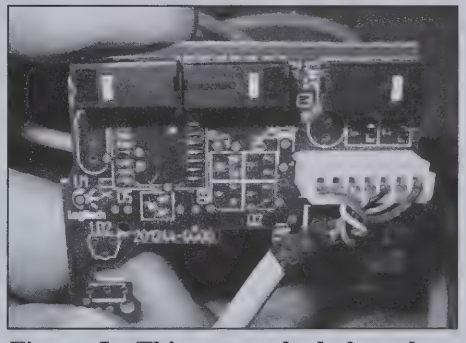


Figure 5—This mouse had three buttons. I used the two left most switches for the maddles.

Usually there are screws of some sort that hold the top and bottom together. Frequently, even with the screws removed we may need to do some prying to get it apart.

Doing this with safety goggles and no one around may avoid eye injuries if the mouse snaps apart and pieces fly. Hopefully the mouse will not be perma-

Figure 6—This small jumper connects the switch ground traces to the mouse ground traces.

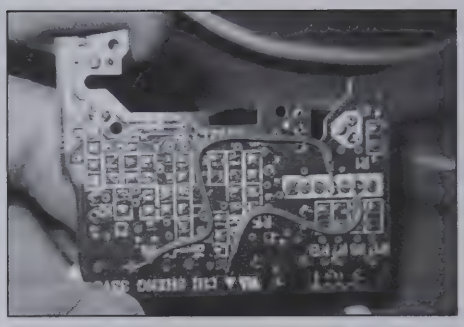


Figure 7—I used wires to connect the switch non-common connectors to the wires on the mouse cable connector.

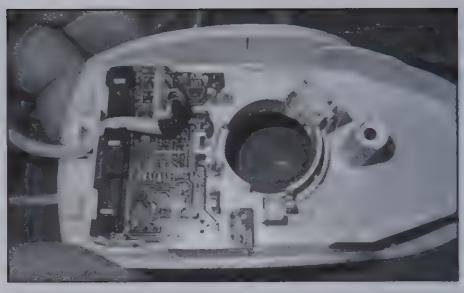


Figure 8—Once we have verified the works with a meter, we can reassemble the maddles and move to the other end of the cable.

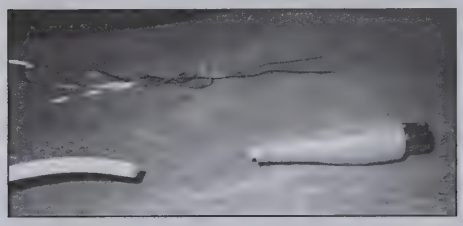


Figure 9—Yes, we can cut off the connector. It may be USB, PS2 or even RS-232. It comes off.

Figure 10—Remembering the wire colors, wire them up to your paddle connector. Here is where we can select where we put the dots and dashes.

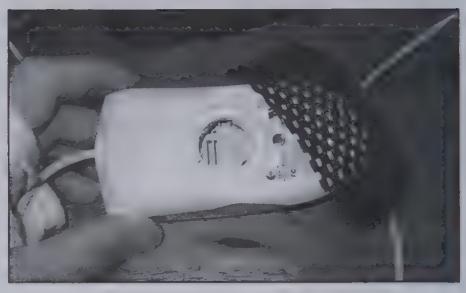


Figure 11—Some grippy material keeps the maddles in their place.

nently broken as we need to eventually reassemble most of the parts.

Once apart you will see that some have a ball and some cute little optical interrupters. The mouse ball poses a choking hazard to young children, so please dispose of it properly. These things are about the same size as the old toys that would lodge in a child's throat. Though they are balls, they are not that much fun anyway. They don't bounce very well.

Find the two (or in this case three) switches that are pressed when the mouse buttons are pressed. They will be right under the buttons that press them. They are usually black and have a small silver lever or button that is pressed by the plastic button on the mouse. These switches are usually soldered to a small circuit board. Remove the circuit board from the mouse housing, and turn it over so that you can see where the switches are soldered to the board. Next, remove all of the circuit board components. You may want to keep some for your junk box. DO NOT remove the little switches or any connector for the cable to the computer. We have plans for these babies.

For each switch take the ohmmeter and place its leads across solder terminals, then press the silver lever or button. You are looking for the ohms reading to go from fairly high to near zero. If the reading goes to near zero when the switch is pressed from fairly high when it is released, this conversion could actually work well. If not (I have yet to find one that didn't work) find another mouse. What you are looking for is two normally open switches.

Our next objective is to get the two normally open switches and a common ground connecting to the wires in the mouse cable. If the mouse has three buttons, I prefer to use the left two buttons for CW. Here we need to get creative. Look at the foil runs around each switch on the pin. The wire that connects to the mouse from the computer will generally terminate in a connector on the circuit board. We need three wires on that connector that need to make contact with the four terminals on the switches.

In the conversion pictured in this article the mouse had three terminals per switch, but the two outside terminals of each switch were connected and conveniently served as a common (ground) when connected to the ground lead on the connector. This was accomplished by installing a small wire jumper between the ground and the common foil. Usually the switches will have a common connection. This may or may not be ground. But you can connect them to the circuit board ground, which will probably already go to the connector.

If you can't find cooperative traces, just cut everything around the connections and solder small insulated wires where you need the electrons to go. In the case of this mouse, after all of the components were removed the switch terminals were not connected at all to ground (common) or one another. I didn't need to cut traces. I just used a couple of wires from a scrap of Ethernet cable to connect to the cable connector on circuit board.

Before reassembling the mouse use the ohmmeter to check that the proper circuits are being made and unmade. Now the readings should be very high to off the scale except when a switch lever is pressed. When the lever is pressed the connection should be made and the signal should go near zero. Also check that you have wired your new paddles to have dash and dot on the side you prefer. Remember the wire colors that you used for the left, right and common (ground) connections.

Reassemble the mouse. Now for the other end of things.

We need to cut the old connector and solder on an appropriate sized connector for your keyer.

In my case I have a PFR-3 from Hendricks QRP. It has a 1/8" stereo socket so I went to Radio Shack. Yes, I actually

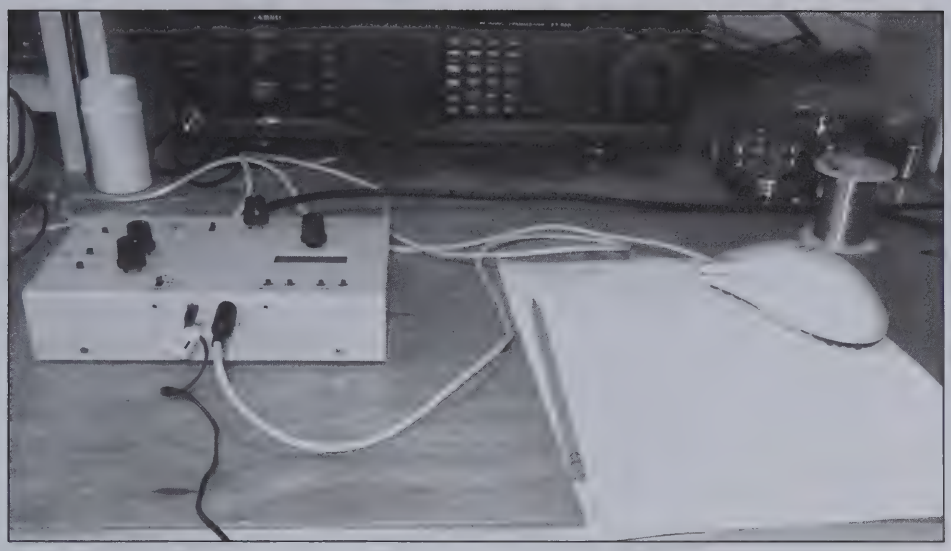


Figure 12—The maddles allow me to send CW and control my rig.

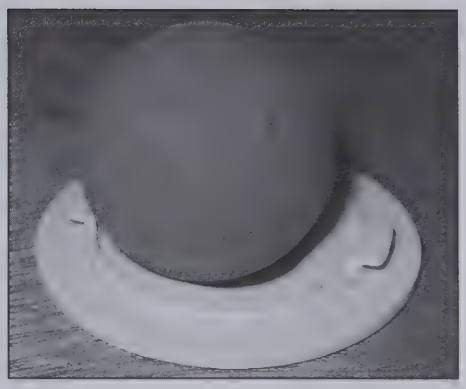


Figure 13—This innocent looking mouse ball can be dangerous for small children. Get rid of it.

spent a couple of bucks on this. I bought the connector and soldered it to the wires at the far end of the cable. If your keyer uses the small 1/8" stereo plugs as found on the cheap stereo headphones, you might be able to splice the wires, but I thought the single wire into the connector housing looked nicer.

I found that, unlike a mouse, a paddle is inconvenient when it lightly slides around my table. I like to glue a piece of self-gripping shelf liner to the bottom of the mouse to keep it in place when in use. Unlike normal paddles, the mouse does not need to have significant weight to keep it in place as the forces on the buttons are down on the mouse rather than side to side.

I was surprised how easy the hand motion was. My mouse had particularly stiff keys, but it still works remarkably well. I use these maddles (this pouse?) for my portable station. A regular paddle set, even a small one, could easily get damaged in transport to various sites.

Although differences with mice makes this a not-so-simple step-by-step project, converting a computer mouse to a portable set of paddles can be a fun first project when moving from kit building to home brewing. This one took me about an hour, with taking pictures. A newbie to home brew might take longer.

●●

2011 QRP-ARCI Contest Schedule

1 January 2011	Pet Rock Sprint
30 January 2011	Winter Fireside SSB Sprint
12 March 2011	HF Grid Square Sprint
2-3 April 2011	Spring QSO Party
29 May 2011	Hootowl Sprint
25-26 June 2011	milliWatt Field Day Contest
10 July 2011	Summer Homebrew Sprint
27 August 2011	Welcome to QRP
10-12 September 2011	End of Summer VHF Contest
15-16 October 2011	Fall QSO Party
1 December 2011	Top Band Sprint
18 December 2011	Holiday Spirits Homebrew Sprint

Working SS With QRP from W1AW

Dennis Markell—N1IMW dennis_m_markell@uhc.com

Did I hear that code right? The call sounded familiar, but too long. I gave another listen. Wow! I guessed correctly, it was W1AW. But wait, I hear more. Tightening my filters and listening closely, I can hear it now. Yes ! W1AW/QRP was the call! What a surprise. QRP from W1AW? Who's working the November CW Sweeps QRP from HQ? I had to learn more.

Asking around my club, I discovered the QRP operator was Sean Kutzko, KX9X, Contest Manager for ARRL. My office is a few miles from HQ so within days I was off to Newington, Connecticut to interview Sean KX9X.

HQ receptionist, Penny, was gracious to this ARCI writer and promptly buzzed the intercom for KX9X. Waiting for Sean, a wise guy heckled at me from a corner of the room "Who works measly QRP?—get an amp!" That's odd, I thought, HQ isn't a place you'd expect an anti-QRP heckler to hang out. Turns out it was ARCI board member Ed Hare stealthily razzing me knowing I was new to ARCI and I wouldn't know who he was. I'll get him back, surely. Watch out Ed!

Sean, KX9X, was very receptive and welcomed to his office for our interview. As one would expect from a Contest Manager, the walls are full of Contest Plaques. In fact, I've never seen so many in one place. The office reveals a ham with lots of interests. Several music posters filled wall space—turns out KX9X is an avid guitarist and musician.

Have you always worked QRP?

No. I was mostly into DX and contesting. But after clearing DXCC and working contests for about 7 or 8 years, I was looking for something new to do. QRP made sense as a challenging next step. So, I started turning down the power on my rig and tested the QRP waters.

So how was your start in QRP?

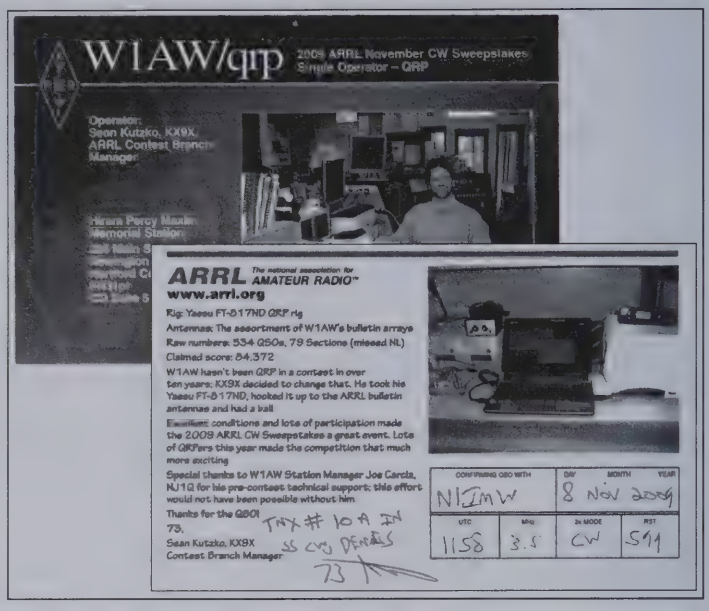
Early on, as many ARCI members would know, it can be slow. My recommendation to new QRP ops is to start out in a high activity environment. Work the contests. Perhaps not the big contests at first. I used to work a lot of sprints and QSO parties and worked many contacts. The big guns aren't as numerous in the sprints and the airwaves are more open, but still busy.

So did you place in any contests working QRP?

As I said earlier, I was just testing the QRP world at first. I knew I wanted to do well, obviously I enjoy contesting and I have a competitive spirit. But to develop a competitive technique I needed more chair time. We all know listening is important. But I needed to re-learn listening for QRP. It is truly an art. Over time I developed my ear and technique and the scores started to rise. Most of those plaques on the wall were won in QRP.

I see. But these plaques say Phone. You were winning QRP on Phone?

Yes I was. I am comfortable with code, and enjoy code regularly throughout the year. But for competition, working QRP phone is even more challenging. I just had to do it. I had to work phone and make it work low power. What I like best is working


W1AW/qrp
2009 ARRL November CW Sweepstakes
Single Operator – QRP
Operator:
Sean Kutzko, KX9X
ARRL Contest Branch
Manager
ARRL The national association for AMATEUR RADIO™
www.arrl.org
Rig: Yaesu FT-817ND QRP rig
Antennas: The assortment of W1AW's bulletin arrays
Raw numbers: 534 QSOs, 79 Sections (missed NL)
Claimed score: 84,372
W1AW hasn't been QRP in a contest in over ten years; KX9X decided to change that. He took his Yaesu FT-817ND, hooked it up to the ARRL bulletin antennas and had a ball
Excellent conditions and lots of participation made the 2009 ARRL CW Sweepstakes a great event. Lots of QRPers this year made the competition that much more exciting
Special thanks to W1AW Station Manager Joe Carcia, NJ1Q for his pre-contest technical support; this effort would not have been possible without him
Thanks for the QSO!
73,
Sean Kutzko, KX9X
Contest Branch Manager
TNX # 104 IN SS CW DENVER
73
CONFIRMING QSO WITH
N1IMW
DAY
8
MONTH
NOV
YEAR
2009
UTC
1158
MHz
3.5
2x MODE
CW
RST
599

others before they know I am QRP. Then, when I tell them I am QRP they are quiet for a while. I don't think they believe me!

What advice would you give to QRP newcomers or contesters?

Working QRP is a mental game. All games and contests are, of course; but QRP especially. We can easily slip into a "think small" attitude. My recommendation, "THINK BIG SIGNAL." ACT like you are a big sound. IMAGINE you are the biggest signal on the air. I've held frequencies during some busy contests for 30 minutes and as much as an hour or so QRP! It CAN be done. You just have to believe.

So what gear did you use for Sweeps QRP CW?

What I really loved about working W1AW was working stacked monobanders. W1AW station manager Joe Garcia is a tremendous asset to the league and manages W1AW flawlessly. He generously helped set me up and I know for sure I worked a lot more station with Joe's help. I live in an apartment, so you know my antenna's are not overreaching! Anytime I can stretch my legs on an effective radiator, I take advantage! For a rig, I used my 817 and a small tuner into the stacked monobanders.

Any final word for ARCI members?

Well, I am sure there's not a lot I can tell ARCI members that they don't already know. I know a lot of members arrived at QRP after years in the Amateur Service. But I do recommend to everyone, keep it fun!

When the day is done, we are here to have fun and enjoy the camaraderie that is Amateur Radio.

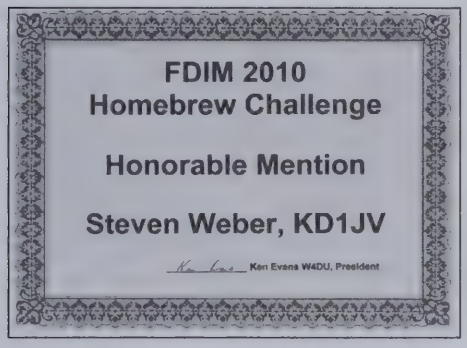
Leaving HQ I had to wonder, how will KX9X score from W1AW? The December flakes were falling and it would be weeks before official word would arrive. Eventually, I did hear back: Points: 81,054 taking first place in the QRP New England Division; highest score ever for Connecticut Sweeps QRP CW. ●●

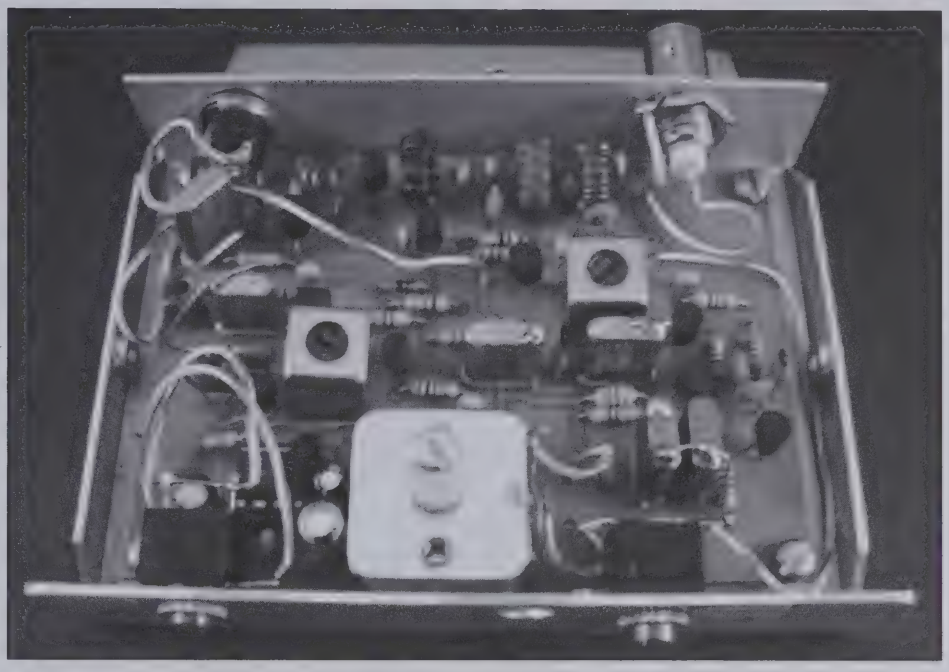
A CW Transceiver for 30M Using 72 Components

Steven Weber—KD1JV

For the spring 2010 FDIM (Four Days in May) design contest, the QRP ARCI decided on seeing if anyone could design a rig using 72 or less parts. What made this design a challenge was the fact the rig had to be a transceiver, the receiver had to have single signal reception and only one IC could be used. The design goal of my version was to come up with a reproducible design, using all common, easy to get and inexpensive parts. It also had to have a reasonably sensitive receiver and a transmitter with a bit more than flea power output. I meet these goals, the receiver having a MDS of about 0.5 μV— not great but usable — and a transmitter which puts out about 3/4 watt. Nearly all the parts can be sourced from Mouser, the exception being the transmitter crystal and the toroid cores.

Five rigs were entered into the contest. I'm sorry to say my rig didn't win the contest (likely due to the receiver not working because of a lead shorting to the case I didn't notice after packaging it). I did however get an Honorable mention certificate:





The inner workings of the 72-part transceiver.

The Circuit

A number of different ideas for a receiver were tried before the final configuration was hit upon. It was quickly evident that making a rig with acceptable performance using only 72 parts was not going to be easy. I kept ending up with 80 to 90 parts. Everything finally came together after I hit upon the idea of using a LM386 as a combination product detector and audio amp. I'm not quite sure what made me think to try using a LM386 in such a fashion and was amazed when it actually worked! I'm not exactly sure how this works, but my theory is thus: If you look at the internal configuration of the LM386, you will see that the two input transistors share a common constant current sink. I believe the RF signals applied to the amplifier inputs are mixed in this current sink and the resulting audio beat note is amplified as if it were connected to one of the amplifier inputs. Some experimentation showed that the BFO signal had to be applied to non-inverting input pin 3 and had to be of very low amplitude. Therefore, pin 3 is left floating and stray coupling is used to inject the BFO signal. The amount of BFO injection is controlled by physically moving R17 closer or farther away from pin 3.

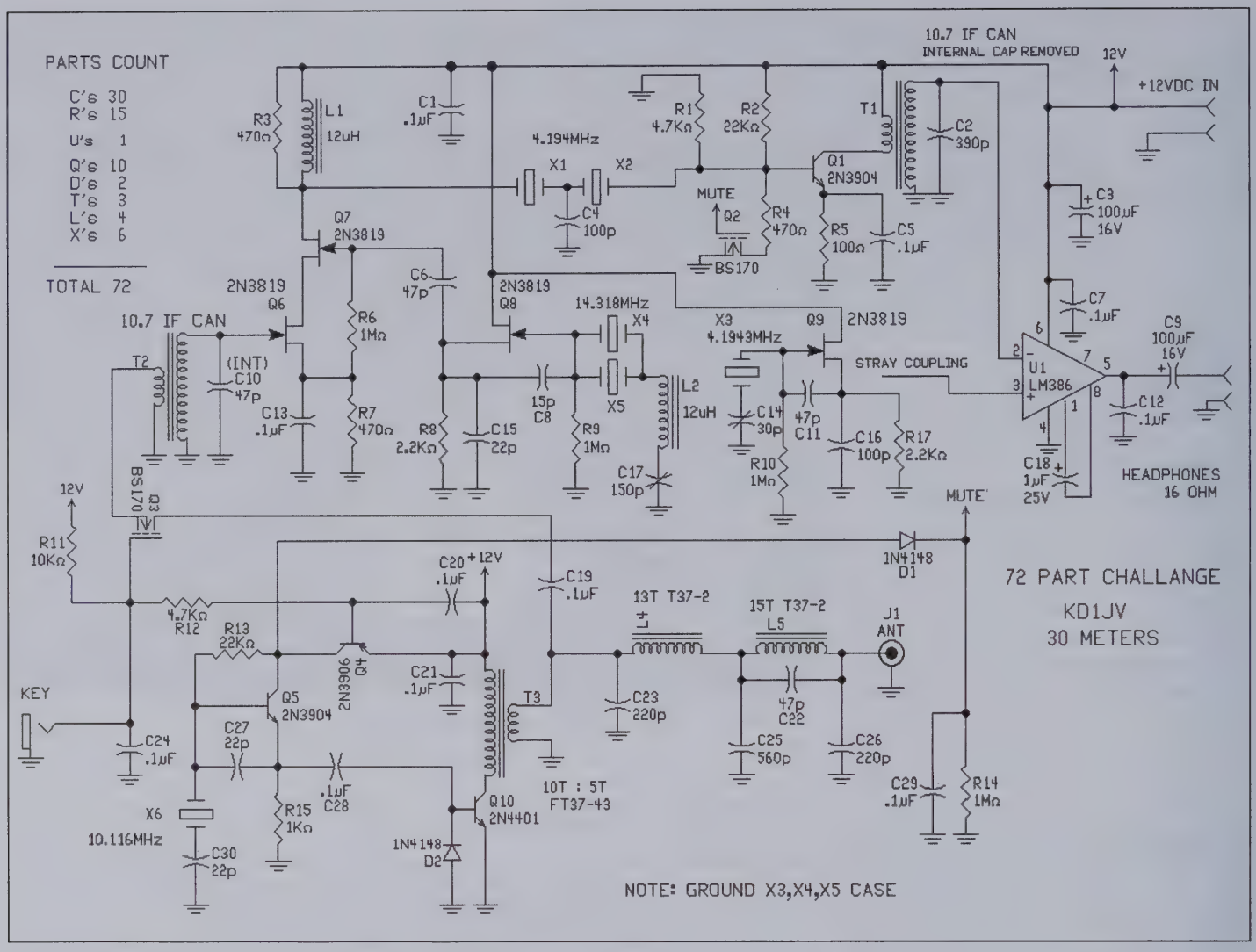
RF bypassing of the LM386 is important and must be done physically close to the chip. C18 across pins 1 and 8 improves the gain of the amplifier. MDS sensitivity of this product detector/audio amp is about 50 μV for a signal applied to the low impedance winding of T1.

The rest of the receiver is pretty standard. A super VXO provides pretty much full band tuning of 30M for the receiver. The mixer is comprised of series connected JFETs, which mimic a dual gate MOSFET in operation. A simple two crystal, one cap IF filter provides reasonably good selectivity and opposite sideband suppression. An IF amplifier is required to get reasonably good sensitivity. Muting during transmit is achieved simply by using a MOSFET to switch a low value resistor to ground from the IF amplifier's base. This reduces the gain of the IF amp without completely turning it off. Sidetone during transmit is achieved by tuning the receiver to the transmit frequency.

Because most of the 72 parts we were allowed to use are used up in the receiver, the transmitter had to be as simple as could be. This meant crystal control. Although directly keying the oscillator would have saved a few parts, using a PNP keying switch allows some wave shaping of the rise and fall time of the oscillator and simplifies controlling the QSK and mute switching. The single transistor output amplifier provides 700 mW of output power. The output low pass filter attenuates all spurs to –50 dBc or better. This is achieved by adding C22 across L5, which makes a trap at the second harmonic. See the schematic (on the next page).

Improvements

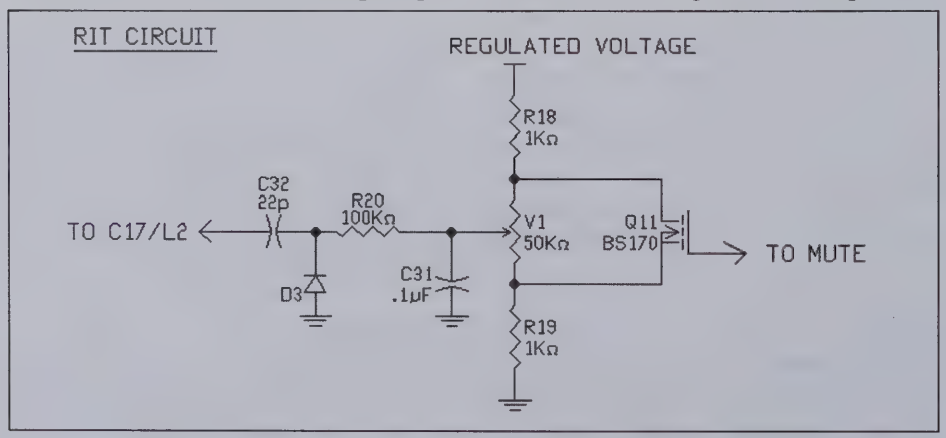
The schematic notes that the internal cap across the T1 secondary is removed and a 390 pF cap used to tune the secondary to 4.194 MHz. This was done



Schematic diagram of the KD1JV 30M transceiver.

because if the internal cap was left in the IF can, it would have to have been counted as an individual part and that would have made the total 73 instead of 72. It really makes more sense to leave the capacitor in the IF transformer and use a 330 pF cap to retune it instead.

2N7000s can be used instead of BS170s, but note that the source and drain pins are reversed between the two types. Therefore, when using 2N7000s, put them in the board 180 degrees from the part outline shown on the board.



RIT circuit for the transceiver.

Adding RIT would improve the usability of the rig significantly. This is easy enough to do and adds about 11 parts. Having RIT would allow keeping the receiver tuned to the transmit frequency to hear a side tone and allow tuning in another station which might not be exactly on your frequency. A suitable RIT circuit is shown below. The RIT voltage divider needs to be supplied with a regulated voltage. This could be either a zener diode and resistor or a three terminal regulator. A voltage of 8 to 9 volts would be suitable for the supply. The way this circuit works is during receive, Q11 is in an off state, allowing V1 to adjust the voltage across a tuning diode, D3. When the transmitter is keyed on, the mute voltage goes high and turns Q11 on, shorting out the RIT control, V1. The voltage across D3 is now centered

at half the regulated voltage because R18 and R19 on either end of the RIT control are equal values.

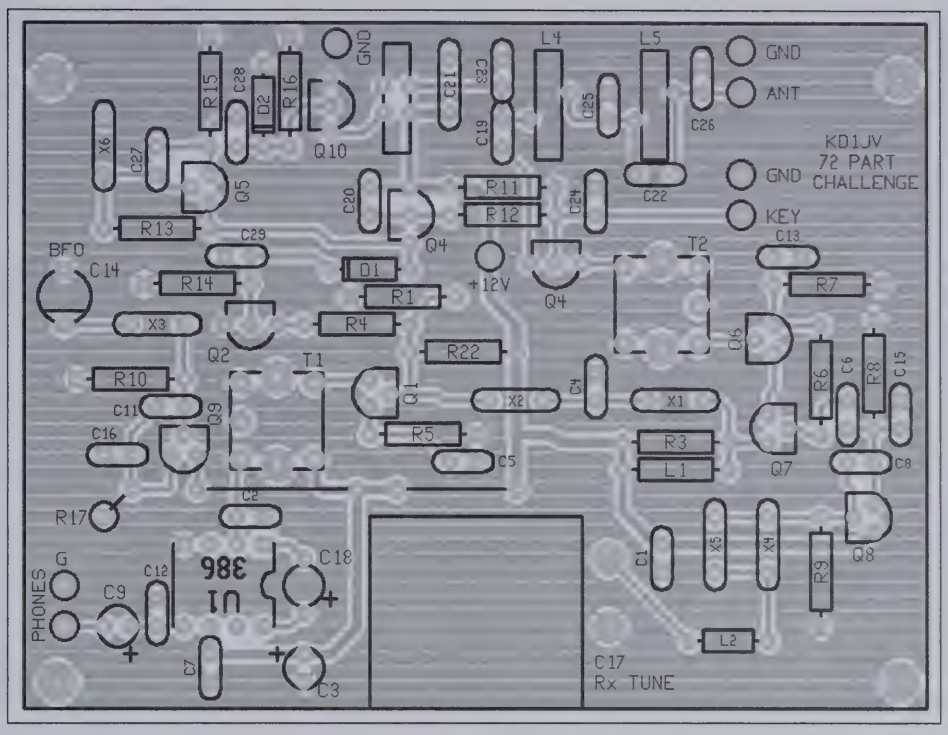
No number is given for D3, as a number of different kinds of diodes will work, with varring degrees of tuning range. 1N4001 diodes will work, as will zeners with a reverse voltage of 20 or more volts. LEDs also make good tuning diodes.

Construction:

I built my rig on a pcb as shown. Dead bug on ground plane should work just as well. The tuning cap C17 is a polyvaricon, which can be taken out of a junk AM/FM radio or bought new from www.qrpkits.com. An air variable would work just a well (if not better, especially if it has a reduction drive built in) just being somewhat larger.

Tune Up

T1 and T2 will need to be adjusted for best receiver sensitivity. BFO trimmer C14 is adjusted for best opposite side band suppression. The position of R17 in respect to U1, the LM386 will affect receiver sensitivity. Tilt the resistor over towards U1 until a high pitch audio oscillation starts, then move the resistor away from the chip until the oscillation stops.



PC board parts layout. Actual size is 3.3" × 2.4".

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VHF QRP: Difficulties Working Long Distances with QRP

James Duffey—KK6MC JamesDuffey@comcast.net

There are several propagation modes that are of interest to VHF operators. Line of sight is well known among all VHF operators, but is limited in distance. Sporadic-E is best known for wide open band conditions in June and December, meteor scatter is slow, but dependable, moon bounce is esoteric, but within the reach of more hams than think they can do it. But the day to day long haul propagation mode for most VHF ops is troposcatter. Troposcatter is scattering from inhomogeneities in the troposphere, that is the upper atmosphere. Those clear air turbulence bumps that you feel when flying at high altitude are also good at scattering VHF radio waves. But they are much weaker than the reflection we see from the e-layer or ionized meteor trails. So signals are weaker. There is lots of QSB, both short term and long term. I will talk about the other propagation modes in later columns, but for this issue it is troposcatter. Troposcatter is always there, sometimes weaker, sometimes stronger, but always there.

Figure 1 is a retouched copy of Fig. 2 from the original *QST* article noted below. This plot shows path loss as a function of distance for the VHF/UHF bands. After calculating your path loss capability, covered in the text, you can determine the distance you can work 50% of the time. Half the time the signals will be stronger, half the time weaker. The deviation is about ±7 dB. Note the more or less flat plateau extending from 75 miles out to nearly 250 miles. In this region, a small increase in station capability can mean a big increase in potential distance to be worked.

Figure 1 is from D. W. Bray, K2LMG, "A Method of Determining VHF Station Capabilities," published in *QST*, November 1961. Over the years it has also been in the *VHF Manual* and the propagation chapter of the *Antenna Book*. The plot is interesting to study in terms of how hard it is to make a contact as a function of distance. The steep rise in path loss for the first 50 or 60 miles is dominated by line of sight propagation. Then scattering in the upper regions of the troposcatter begins to dominate propagation and the path loss levels out. As the distance increases further beyond 250 miles the loss starts to increase more steeply, primarily due to the loss in scattering volume as the radiation solid angle begins to increase in altitude outside of the troposcattering volume. The scattering volume, and hence the scattered signal is decreasing in this regime. Beyond 400 to 500 miles, propagation is beginning to shift to ionoscatter in the E layer, except during those times when Sporadic-E or F layer skip occurs. During these skip conditions, the path loss can be very low, especially under strong Sporadic-E conditions.

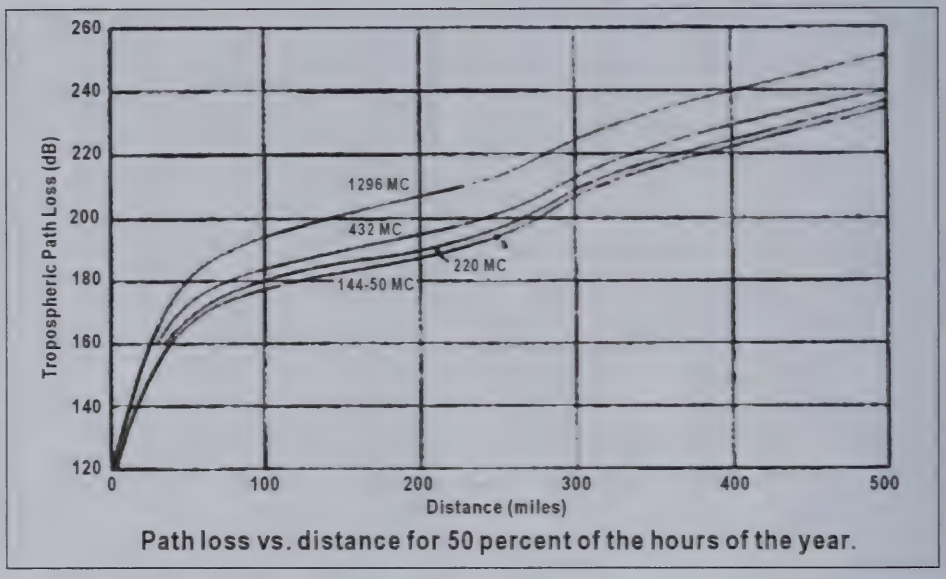

Figure 1—Path loss plot from K2MLG's 1961 *QST* article.

To put things in perspective, I have calculated the path loss for several frequently encountered two meter rig combinations are shown in Table I. The path loss capability, *plc*, in the table is calculated simply:

$$plc = eirp + ers$$

where *eirp* is the effective isotropic radiated power of the transmitting station and *ers* is the effective receiver sensitivity of the receiving station.

$$eirp = (10*\log(P)) + Gtrans - transTL$$

where P is the radiated power in watts, *Gtrans* the gain of the transmitting station's antenna and *trasnTL* is the transmission like loss for the transmitting station.

$$ers = -10*\log(k*T*B) + Grecv - recvTL - threshold$$

where k is Boltzmann's constant, T the effective receiver noise temperature, B the receiver power bandwidth, *Grecv* the gain of the receiving station's antenna, *recvTL*, the loss in the receiving stations transmission line, and threshold the receiving threshold required for modulation types. For CW and SSB this is 0, for FM it is 10 dB.

The receiver noise temperature, T, is calculated from the receiver noise figure, *nf*:

$$T = ((10\text{^}(nf/10)) - 1)*290$$

I use MathPad, a free Macintosh mathematical worksheet calculator to calculate the PLC for specific situations. You can also use MathCad, MatLab, or even an Excel spread sheet to calculate path loss for your particular situation.

There are, of course, many other combinations. The above combinations are representative of stations in the QRP portable class, newcomers, or casual contesters (the infamous Joe-706 pack) with home brew WA5VJB Yagis, the modest contester, and the serious contester. As you can see, there is a significant improvement in going from FM with a vertical to SSB with a small

Transmit Station	Receive Station	Mode	Path Loss Capability (dB)	Distance (miles) for SNR=10
5W HT 1/4 wave	HT 1/4 wave	FM	156	15
5W HT 1/4 wave	Long Yagi, low noise receive	FM	170	30
FT817 3 el Yagi	FT817 3 el Yagi	SSB	184	80
FT817 3 el Yagi	FT817 3 el Yagi	CW	195	130; 260 miles for 0 SNR!
IC706 6 el Yagi	TS2000 Long Yagi	SSB	207	250
IC706 6 el Yagi	TS2000 Long Yagi	CW	214	310
TS2000 Long Yagi	TS2000 Long Yagi	SSB	215	270
TS2000 Long Yagi	2 dB NF, stacked Yagis	SSB	223	300
kW, Stacked Yagis	2 dB NF, stacked Yagis	SSB	236	400

Table 1—Path loss capability for typical 2M station configurations.

gain antenna at the same power level, and a significant improvement in going from SSB to CW, largely due to reduced bandwidth. But the long haul contacts are the domain of big stations. That helps the QRP operator, as the big station does most of the heavy lifting. If you can't raise someone on SSB, give a shout on CW. In practice, CW can be copied at levels down to SNR = 0, which will extend the CW distance even more in the above tables. One can determine how much the distance is extended by looking at Figure 1.

If you have a QRP VHF rig, you can really extend your workable range by going from a simple vertical to a Yagi, or from FM to CW. If you have a small beam, you can tweak a few more miles by gong to a longer one.

The plot is for 50% path serviceability—half of the hours of the year the path loss will be less than this, and half the time it will be more. The plot assumes a smooth earth; any obstructions in the path will usually make things more difficult. You are unlikely to experience a smooth earth, except perhaps in the great plains, such as a path from Brookings, SD to Wall, SD. One can generate more accurate plots using path prediction software such as RadioMobile or SPLAT!. SPLAT! is available as an internet application:

http://splat.ecok.edu/

courtesy of W5GFE. In practice, the signal strength will vary ±7 dB or so about these signals, with signals being better in the summer than in the winter and better shortly after sunrise and sunset than at midday.

The figure, or the software, can be used to calculate similar figures for other bands or other station capabilities.

The FM HT operator who stumbles across VHF activity is unlikely to work much DX even if he upgrades to a mobile class transceiver. Going to the weak signal modes, CW and SSB, buys one a lot of distance Most casual VHF operators can work out to 250 miles with some effort, the modest VHF station to 300 miles plus, and the serious contesters can work 400 miles or so. These distances are not always easy, but with patience they can be worked. My calculations are theoretical, but they are not too far off from what is usually accomplished in practice.

Prepare for the Winter Sporadic-E Season

While working sporadic-E in the early summer is standard fare on 6M, and occasionally on 2M, less well known is the winter sporadic-E season. Although not as pronounced as the summer season, there is another Sporadic-E season centered around the winter solstice, roughly December 21, that is underutilized. Sporadic-E is well, sporadic, but lots of fun, and you can work out to 1300 miles on single hop, or twice that distance on double hop, and so on.

Although the openings are fewer, and usually weaker than the summer season, it is worthwhile being prepared to take advantage of winter openings. The best way is, starting around December 1 or so, turn on your 6M rig when you are in the shack, and monitor the calling frequency, 50.125 for activity. Also, monitor DXSherlock:

http://www.vhfdx.info/spots/map.php?Lan=E&Frec=50&ML=M&Map=NA

for openings on your computer. Listening to white noise can be stressing, particularly to family members who are not hams, so if that bothers you, lightly turn up the squelch. If the skip gets short on 6M, go up to 2M. short skip during a sporadic-E opening often means that the next highest band is open. Also give a CQ on occasion as that can yield surprising results.

Now is also the time to put up a better antenna, or a longer one, or a higher one. Replacing lossy feed line will also help. But no technology will replace getting on the air and listening for an opening. It is easy to have a 6M rig on while you are doing other things on around the shack. You can't make contacts if you are not listening.

January Contest

The ARRL January VHF contest is the weekend of January 15-17. Contesting is a good way to hone your VHF operating skills, collect grids, and make contacts with local VHF operators. There is a special QRP Portable class, although options for portable operation in January can be limited if you are in the colder climes. Full details are available here:

http://www.arrl.org/january-vhf-sweepstakes

New Columnist

I am taking over this column from Bob Witte, KØNR. Bob has done yeoman's duty in writing this column and I hope that I can continue to write this column to his high standards. If you have anything you would like me to cover, let me know, and I will try to address it. Questions about QRP VHF operating are also welcome, feel free to write me at my QRZ.com address or drop an e-mail to JamesDuffey@comcast.net

I would also like you to share your VHF operating experiences with me; pictures are particularly welcome. Send them in. Same with VHF/UHF home brew projects. This is your column; I am just the facilitator.

There is no doubt that QRP operating at VHF can be hard. I hope that this column can make it a bit easier for you.

—72, KK6MC/5

Review of the Flex 1500

Preston Douglas—WJ2V PDouglas12@aol.com

This is a review of the new Flex 1500. Figure 1 is screen shot of the 1500 tuned to WWV. Note, at this point it is 3 Hz off as supplied from the factory. I bet there are very few rigs that can boast that kind of calibration on arrival.

The Flex 1500 is a QRP all band, 160 to 6 meters, all mode transceiver. It is not a conventional rig; it is SDR—software defined. This means that a lot of the radio exists only as software in your computer.

Hookup of the Flex 1500 is pretty close to plug and play insofar as the hardware, at least. The computer connection is a standard USB cable, supplied. No firewire card needed for this little Flex. Your station 12-13.6 V supply is fine, and the power cable is supplied with the proper connector on one end and tinned wires at the other. I just soldered on a set of Anderson Powerpoles. You will need a set of powered computer speakers, not supplied.

One of the first questions newcomers to SDR ask is what modes these rigs will run. The simple answer is, all modes. The Flex 1500 box is tiny, 6×4×2 inches, which makes it QRP-sized too. Of course it has to be hooked up to a computer, which immediately makes it a lot less portable. And for this application, laptops should be higher end jobs, not the cheapie ones. Some ops have reported limited success with even with these lesser machines, but it is clear that a faster computer is needed to avoid some of the problems that come up in SDR radios in general.

Look at this next screen shot (Figure 2) which has a lot to show. I have Flex 2.08 (beta) running as the virtual radio software; I have MMSSTV running. I have no interface cables or Rigblasters—everything is connected virtually inside the computer. To make all this happen I have no fewer than five programs working (three behind the scenes to connect the on-screen programs, virtually. I am running a 3.2 GHz P-IV with 3 GB RAM to do all this, and it is running at around 16% CPU usage.

Wait, you're saying, what about the rig? Isn't this supposed to be a review? Yes. But you have to get a flavor for this kind of operating, because this isn't your father's Knight Kit here:

Now look at the Flex front panel above.

Figure 1—"Front panel" of the Flex 1500.

It shows a slice of the SSB sector of 20 meters, though it can show a wider slice, up to 48 kHz. One of my real gripes about the F1500 is that is won't go wider than 48k at a time in the panadapter, no matter what you do. That is its limit, period. If you want more, you'll have to buy a Flex 3000 (96K wide), or build a kit from one of the kit makers out there. Look at the MMSSTV panel in the foreground. This

Figure 2—Display of a segment of the 20M SSB band, plus a MMSSTV picture.

shows a picture that AD5C sent me, with a send-back of my own picture I sent him showing my little Welsh Terrier. If you look closely at his picture, it shows a line of dogs waiting for the bathroom. I thought this was hysterical.

As to setup, getting all the programs to actually exchange data properly was very challenging. I found that I needed help from other Flexers, as they are called. And the online Flex dosants are all very good. For example, I learned that in order for MMSSTV (which was written before the SDR era) to work with virtual audio cables, a special program has to be inserted into the MMSSTV folder. A simple download, and it was cured.

OK, I confess. For SSTV five watts is generally not enough for just messing around on 14.230. I run a fan-cooled Packer Amp at 25 watts from the F1500. It is a perfect match for the little Flex rig, and it will do about 35 watts SSB/CW. Before you start thinking about expelling me from QRP ARCI, I don't use the amp for PSK31, as I find 5 watts is plenty.

Oh, sure it does PSK31. Figure 3 is a screen shot of the Flex running DM780, the brilliant multi-browser for PSK31 that is part of the Ham Radio Deluxe Suite. Look at the Flex front panel above to see the signals themselves in the Panadapter, while DM780 shows them in its own waterfall. If you haven't tried PSK31 before, you're missing a lot of fun. If you have, then operating with the Flex will still be a treat.

CW... Here comes the second "gripe" if you want to call it that. The F1500 is not ready for QSK, and I don't know if it ever will be. Those of you who know the history of the Flex 1500, and particularly those of you who were on a wait list for over a year, know that FlexRadio got the F1500 finally out the door in July, 2010. Mine, ordered in May at Dayton, was only a two month wait, but they got it out. Now, there are neonatal problems. As Jim Stafford described it, the internal keyer isn't working right yet, and, while an external keyer works fine, the external sidetone must be used. Jim says, attempts to use the internal monitor for sidetone is like listening to the announcer in Yankee Stadium. The delay makes it impossible to send. Jim says it works just fine with the external keyer sidetone, and both of us agree we love the CMOS III for our station keyer, having

Figure 3—The Flex 1500 running DM780 PSK31.

never found anything superior. If you're a contester, though it doesn't have QSK, the F1500 still has advantages, so long as it's used with the external keyer. You don't have to tune slowly, listening for the next signal up the band. You can see it, and pounce on it with your mouse, giving new meaning to hunt and pounce. It isn;t QSK, but the turnover is reasonable. Caveat: if you're a high speed CW conversationalist, then you may miss your QSK.

Flex has had to rush and so they have been sending out beta updates every couple of weeks. They have not released a finished version of PSDR 2.*xx*, and there are still bug lists to resolve. Most significantly, they have been forced to use a workaround for the Windows drivers because a subsystem they purchased from an outside company has a serious bug itself. I think this is really temporary, but as I write this at the end of August, it's not done. No doubt, they're working hard on this. Perhaps, even, when the "direct" driver becomes available, the QSK problem will resolve. Also, to paraphrase Henry Ford, you can use any operating system with PSDR 2.*xx*, so long as it's Windows. In other words, multiplatform software for the Flex hardware is a way off.

I don't have a picture for you to show the radio working on sideband or FM. Suffice to say, my signal reports on SSB are excellent. With or without an amp. So Flex already has the basics working very well.

Here's what I would tell FlexRadio if I were hired as a consultant. You need to integrate your software so that it is, once and for all, plug and play. Lots of hams have expressed frustration at how complex it is to make Power SDR (PSDR is FlexRadio's trademark radio software) work with third party programs like DM780 and MMSSTV. Modes like these should be fully integrated. A simple program called Rocky, still in use, has a rudimentary PSK31 capability built-in. Why isn't it in PSDR? Beyond the integration issue, it bothers me that I had to purchase an outside program called Virtual Audio Cables, or VAC, for $30 in order to use any digital modes. The guy who wrote VAC deserved my money because he wrote it, and because nobody else did. But my F1500 should have come with VAC, in my opinion, since it is supposed to be all-mode. And, though I didn't have to pay extra for it, it is also bothersome that a program to create virtual serial cables also had to be downloaded for digital operation to work.

After I wrote the last paragraph, I went back and re-read the review in the April 2005 issue of *QST* in which the original Flex 1000 was reviewed. Know what? Steve Ford said the same thing. He hoped that the digital modes would have been integrated into PSDR. Five years later,

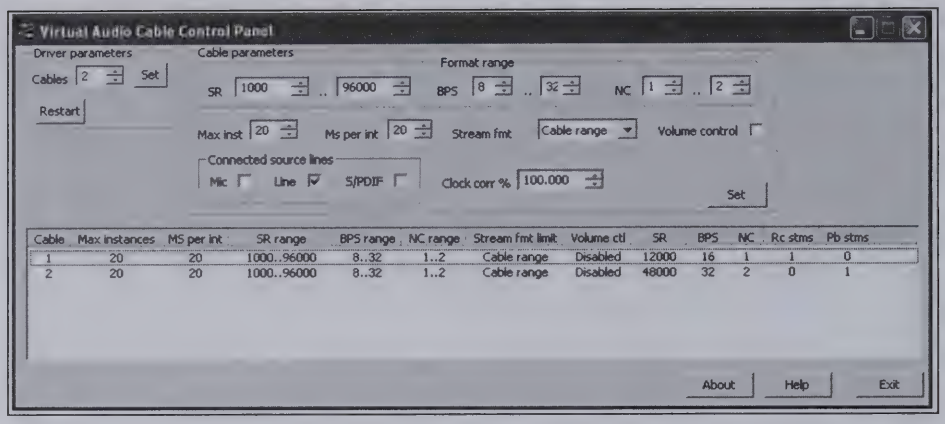
Virtual Audio Cable Control Panel
Driver parameters
Cables 2 Set
Restart
Cable parameters
Format range
SR 1000 .. 96000
BPS 8 .. 32
NC 1 .. 2
Max inst 20
Ms per int 20
Stream fmt Cable range
Volume control
Connected source lines
Mic Line S/PDIF
Clock corr % 100.000
Set
Cable Max instances MS per int SR range BPS range NC range Stream fmt limit Volume ctl SR BPS NC Rc stms Pb stms
1 20 20 1000..96000 8..32 1..2 Cable range Disabled 12000 16 1 1 0
2 20 20 1000..96000 8..32 1..2 Cable range Disabled 48000 32 2 0 1
About
Help
Exit

Figure 4—A third party program like VAC (Virtual Audio Cable) is needed to configure the PC/radio combination for digital modes.

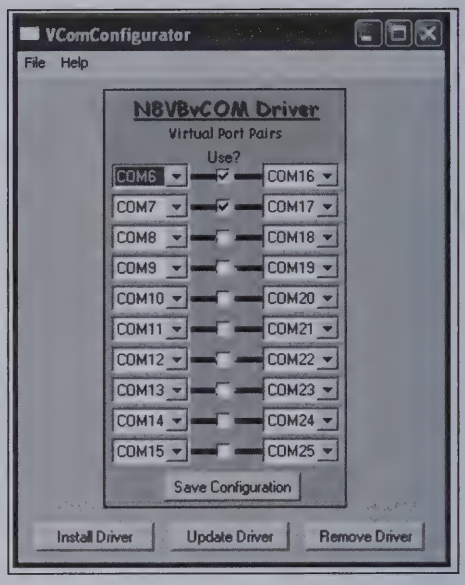

Figure 5—Virual serial cable screen.

they're still not.

VAC is a program that creates the virtual audio cables that replace the box and wires between your conventional rig and computer when you operate digital modes like SSTV. These virtual cables connect the audio output from PSDR with the digital program like MMSSTV. There are no cables and no interface, just virtual cables.

Figure 4 shows what the third party program, VAC looks like. Looks complicated? It is—a little. Plus, to make matters a little harder, there is a VAC settings page in PSDR; it depends on the third party VAC program to function. Figure 5 shows what virtual serial cables look like on-screen.

So, with all these criticisms, should you buy this rig? Without hesitation, yes. It's not proper to review a radio and pull the punches, so I didn't. But I have to say this is a terrific little radio. I have had more fun with it than I have had in a long time in ham radio. I love it for digital modes, which have pretty much become my favorites. Should you wait until they have exterminated the bugs? I don't see why you should wait. The software is already functional and the bugs are small; they do not interfere with routine operation, and I find most of these aren't significant in my shack. I probably wouldn't even be in the shack if I didn't have this radio to play with. I paid $649 on faith, a special Dayton deal, with no shipping cost. That deal is over now that FlexRadio is shipping from stock. But at $700, the radio is worth the money and then some. It is, in fact, a lot of radio for the money, even though the little box it comes in seems too small! And no, I don't think saying that you already get a lot for your money is inconsistent with expecting the software to be more plug and play.

Things I haven't done with my F1500 yet: I've never, ever worked six meters with any rig. It's on my to-do list. I want to buy and connect up a transverter for two meters and also maybe try satellite operation. For that, I know I'll need an external frequency standard. The F1500 has an input port for direct discipline by an Ru or GPS standard.

Oh, you want to know about the receiver? It's excellent. Surprisingly sensitive, and of course the virtual/digital filtering is great. Want to cut off an interfering signal that's nearby? Just cut it off, and it's not there. If you haven't yet tried operating with an interactive panadapter, you should. For me, operating a regular radio now is like operating blind. I can't go back anymore.

Ever since the first *QST* review of the first Flex radio, the F1000, in 2005, there have been some complaints about incomplete development. The authors in *QST* note that they had to review based on the software version that was available when they started the review, and new versions came out while the article was in the pipeline. The same thing is likely to happen with this review. As they said in *QST*, you have to stop and take a snapshot at some point. Latency is the problem that plagues SDR radios, though it has steadily improved, particularly as drivers and CPUs have improved and sped up. Now, five years up the line, we're still talking about it. When speeds get fast enough, QSK will work. (Really, you know, QSK isn't instantaneous in any rig, just faster than you can perceive; so long as you can hear the receiver in between the dots.)

This is what it means to be in the frontier. Things change as you go. Meanwhile, I'm going back to work some SSTV on twenty. And then maybe I'll set the little 1500 to WSPR for a while on 30. I forgot how much fun radio can be.

—Preston Douglas WJ2V

Postscript

Ken Evans (with my permission) sent the above article to Gerald Youngblood, CEO at Flex, for his comments. He suggested that I had the supply voltage range a little wrong, and I stand corrected that the top voltage is not 13.6 V; it is 14 V. He also advised that changing the blanking delay on the transmit setup tab would eliminate the delay-echo in CW mode. We've tried this, and it does help a lot. The rig is still far from QSK, though, and we hope the forthcoming direct drivers will help to resolve this issue. Youngblood also suggested that perhaps it isn't Flex's job to re-invent the wheels of digital softwares like MMSSTV and DM780, etc. He points out that they are already highly developed pieces, and after all, conventional radios use these programs too. He allows that, however, Flex should eventually incorporate VAC and VCOM, the virtual audio and serial cables needed to connect up these third party digital programs. We agree with him to the extent that Flex ought to have the virtual cabling built-in, so that Flex SDR radios can connect to third party digital software as easily as conventional radios can.

●●

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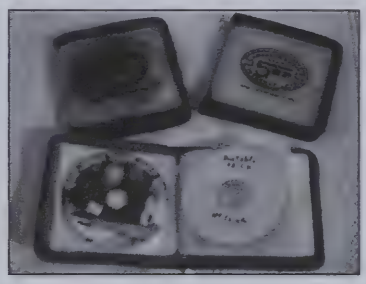

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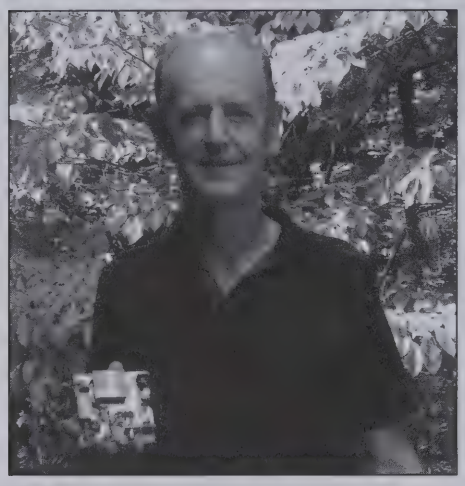
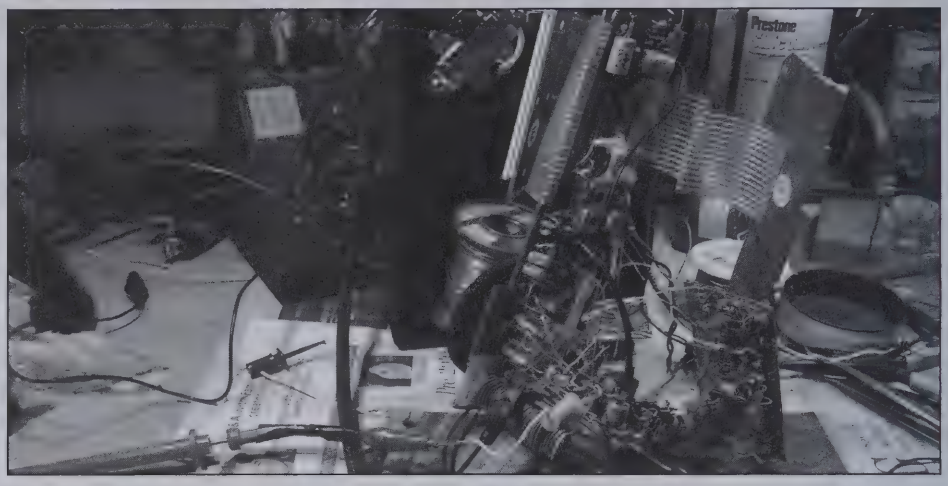
A Tale of Good Fortune for FDIM 2010

J.A. Roberts—NC9H jrobim@hotmail.com





The first try—a modified clock radio—on the workbench.

When I first saw the announcement for FDIM's 72 Part Challenge, I came up with a plan to work over an old clock radio built around one chip, a TA7613AP. (1) I thought I had it made since the IC included almost all the necessary circuits plus a kitchen sink. Boy, did I hit a wrong chord on that one! By then I had poured half my junk box into that setup. I should have remembered it is always better to make your own than to fix someone else's design. I actually finished, and am now using, this radio, but trust me, it has far more than 72 parts, more like 172 or even 272 of them. FDIM didn't want a wake up alarm or a coffee maker!

After being knocked off my pedestal by this reality, I started over, determined to be, if nothing else, austere. I pounded out shielded boxes from tin can lids. Wire leads were dressed tight against the board [2]. A diode detector was turned around so no DC blocking capacitor was needed. I was becoming obsessed.

My wife calls them squashed china berries. You and I refer to them as *bypass capacitors*. Whatever, any time one could be eliminated,, it was practically shot out of the circuit with a gun. I was on a roll. New politically correct terms shot up: Central Bypass, Regional bypass, Nuclear bypass. Then, horrors, one night I had a dream whereby all my bypasses were swept out by one huge red capacitor, as big as a Hoosier Heirloom tomato. Nothing could be worse.

The project droned on. Little by little things took shape—a Gilbert Cell front end, an inexpensive crystal filter, a two stage IF amp, and a two transistor audio amp. Receiver gain was mediocre and I had to use headphones. This was no good.

I kept a careful parts count stage by stage. I wanted to try regeneration in the IF, since it didn't have a bypass close by anyway. The "Big Tomato" would take care of that. I put 220 pF across the unbypassed detector and, voila! the gain shot up

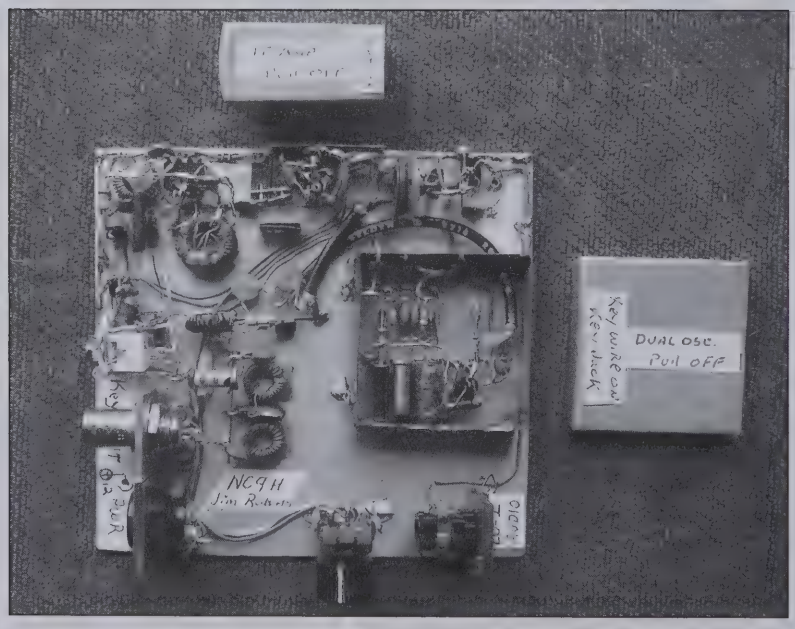
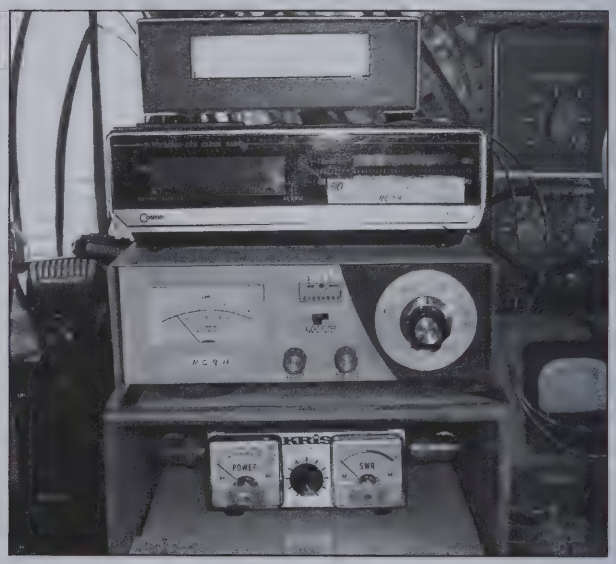


Photo of the radio with shield covers removed to see inside.



The FDIM Challenge radio at the operating position—just under the now-infamous clock radio conversion.

like a rocket. At first I didn't believe it. The gain was too high. Now I could afford to sacrifice some of it by changing the second audio voltage amplifier to an emitter follower with heat sink [3] which would step down the impedance and drive a loudspeaker. Hooray!

The rest of the set fell into line. The crystal oscillator doubles as the transmitter oscillator and receiver BFO. Offset tuning in the receiver is actually a tuned VFO with narrow range. The single stage transmitter runs less than 100 mW. However, early one Spring day, I did work Arnie, from Cambridge, Ontario, Canada using only a dipole 12 feet off the ground. What a blast! Suddenly there was hope for the project.

For two weeks, much to my wife's dismay, this 72 part radio sat on my breakfast table surrounded by diagrams,. The diagrams were under constant correction. It's amazing the number of mistakes that can be made on a schematic diagram. Every time I thought I was finished, I had to correct it again and rescan it into the computer and then print a copy. It went through a daily parts count and various on the air tests, thanks to my friend, Denny Payton, N9JXY, who lives across town. With the ear of a symphony conductor, Denny affirmed that the signal sounded proper. Finally satisfied, I labeled and packaged my entry. It was a good project. As an amateur radio hobbyist, I was thrilled that my entry made it to the finals. The 72 part challenge was a great learning experience [4].

References

1. Toshiba part number. Also Sprague ULN2204A who provides a useful data sheet.

2. The Oscillator box has a lid with overlapping edges. The IF amp pull off shield is fitted into tin slots to ensure RF grounding.

3. The 2N3904 is glued to a piece of steel tack soldered to the board.

4. I want to thank Ken Evans, W4DU, for taking my entry to the meeting and arranging for its return. Ken was most helpful to me.

Notes on the FDIM 2010 Radio—

1. Observe polarity of diode—blocks DC from preceding stage. Negative peaks are detected.

2. Volume control serves as a 10k diode detector load.

3. 220 pF develops feedback and regeneration. Place a small shield around this and I.F. amp. Do not bypass volume control.

4. Chose one xtal from the group (example—buy 6), that is lower in frequency by 500-800 Hz

5. Inductor was chosen to lower the frequency further

6. 12 V power goes to Central Bypass for the following:

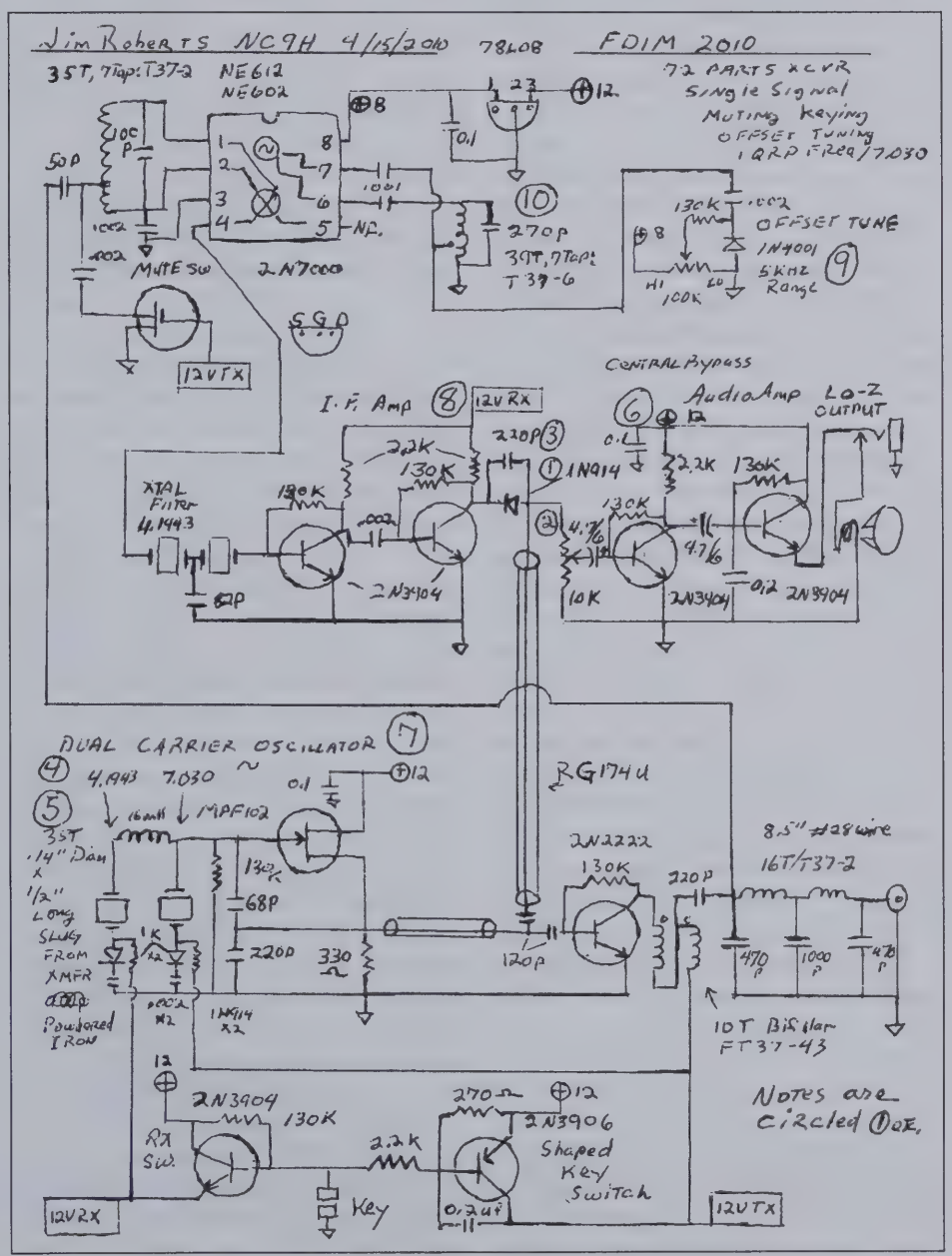
- Audio amp
- Mixer voltage reg. input (output also bypassed at mixer)
- Dual oscillator

7. The dual oscillator (which is the IF carrier and transmitter carrier oscillator) is also bypassed internally, inside its shielded box.

8. IF amp is supplied by 12 V on RX. It is "off" on transmit so that the regenerative signal does not interfere with the transmit signal.

9. Transparent glass diodes may be light sensitive and can be covered with black tape tied on with thread or floss. Better to use a black encapsulated diode.

10. Spread and/or compress turns to adjust frequency. Also may have to choose from several 270 pF caps to find one that is correct. (A variable cap may be substituted.) ●●



Schematic of the final design for the FDIM 72-Part Challenge Radio.

Notes on Measuring Quartz Crystal Motion Parameters

Dave Gordon-Smith—G3UUR
daveg3uur@googlemail.com

The widespread use of quartz crystals in personal computers and other digital devices has resulted in an incredible range of stock HF crystals becoming available to the amateur constructor. Mass production has made these crystals extremely cheap, though not always as consistent in performance as might be hoped. Often there is considerable variation in their quality, and this is a fact that needs to be considered when embarking on a crystal filter construction project. I think it's true to say that the time and effort taken to characterise crystals properly before making a filter always pays off in the long run. The proof of this approach is most evident in the perfection of the filter pass band. This is the feature that is most sensitive to variations in crystal parameters and component values. The stop band will generally be pretty close to the design specification as long as the values are roughly in the right ballpark.

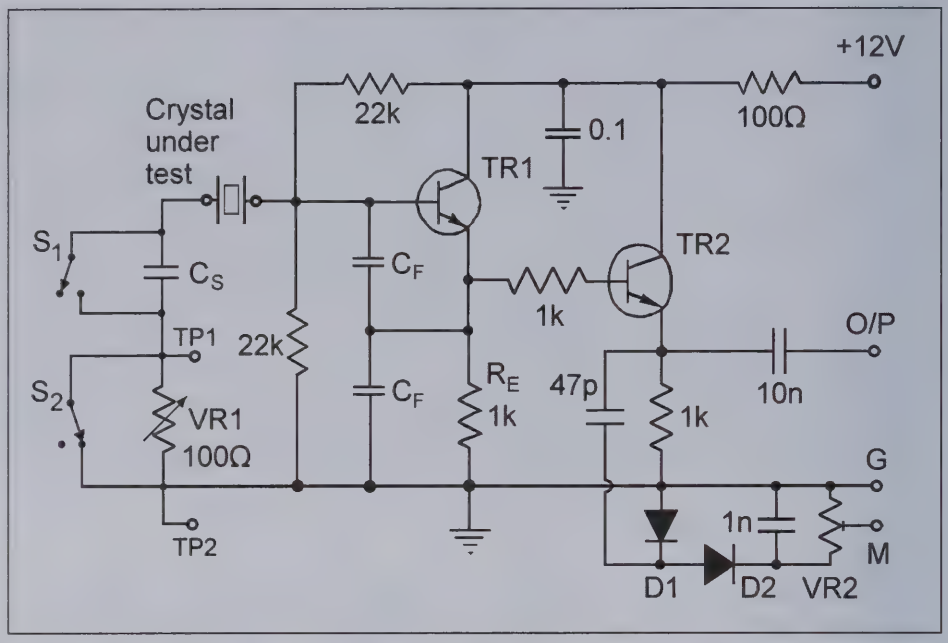


Figure 1—Oscillator circuit for measuring crystal motional capacitance by the frequency-shift method (C_F is normally about 470 pF and CS around 33 pF).

Electronics, particularly instrumentation, has come a long way since the author started making crystal ladder filters with very primitive test equipment in 1977. The vector network analyser (VNA) is undoubtedly the single most useful piece of test equipment available to the amateur today, and can be used for crystal characterisation as well as filter testing. However, a VNA is a major project in itself and for those who are just beginning, or only want to build a crystal filter once every so often, the simple approach can still be the best option.

These notes are meant to supplement what has already been written about the G3UUR frequency-shift method of motional parameter measurement. They include instructions on how better accuracy can be obtained, and also give details of simple changes and additions to the test circuit popularised by W7ZOI that allow a more thorough characterisation of quartz crystals to be performed.

Crystal Variation and Measurement

Mass-produced crystals generally have a reasonably tight frequency spread, but their Q values can vary widely. The unloaded Q of a crystal, Q_u, is defined as $2\pi f L_m/R_m$, where L_m is the motional inductance and R_m the motional loss resistance. R_m is also known as the effective series resistance (ESR) of the crystal, and is low for crystals with high Q_u. High quality crystals usually have a spread in their ESR values of around 2:1 from worst to best. Commonly available cheap crystals can vary by more than 6:1, and that's excluding the dead ones! These cheap crystals still represent good value for money, though, and the better ones are eminently suitable for high-performance crystal ladder filters. They just need to be characterised thoroughly and selected carefully to weed out the less suitable ones. Wes Hayward, W7ZOI, has promoted the G3UUR frequency-shift method as a simple means of measuring crystal motional capacitance in his book *EMRFD* [1] and one of his earlier articles [2] in *QEX*. It is simple, but can also be accurate and more thorough without much of an increase in complexity. The purpose of this article is to explain how that can be achieved.

The formula for C_m presented by W7ZOI is a much simplified and less accurate version of the exact derivation for C_m. Better accuracy can be achieved with the simplified version used by the author,

$$C_m = 2(F_2 - F_1)\,[C_S + C_0 + C_R]/F_1 \quad (1)$$

For those unfamiliar with the method, Figure 1 shows the schematic of the frequency-shift oscillator. The feedback is provided by two identical capacitors, C_F, and the frequency of the crystal under test is switched between F_1 with C_S shorted by switch S_1, and F_2 with S1 open. S_2 is kept closed for all frequency measurements. The value of C_F is usually chosen to be in the range 330 to 560 pF, with 470 pF being quite a common choice. C_S needs to be around 10 times the value of C_0 and is commonly 33 or 39 pF. It's best to use capacitors with 1% tolerance for C_S and C_F if you can find them. S_1, a miniature toggle switch, should have CS wired directly across it, and the 1 pF capacitance of the open switch should be added to the value of C_S. In Equation 1, C_0 is the total parallel capacitance of the crystal, and $C_R = 4C_S \cdot C_0/C_F$.

For a typical 9 MHz crystal with C_m = 0.01 pF and C_0 = 2.7 pF, the error in C_m using W7ZOI's simplified equation is around 20% compared with 0.1% for Equation 1. The results using the frequency-shift method can be better than ±5%, depending on the tolerance of C_S and C_F, so it's worthwhile using the more accurate approximation for determining C_m.

However, W7ZOI's simplified equation can be used to establish a rough value for C_m when no means of measuring C_0 is available. In such cases, the rough value of C_m (in pF) can then be used to provide an estimate of the value of C_0 (in pF) using

$$C_0 = 175C_m + 0.95 \quad (2)$$

This equation is based on a physical relationship that exists between C_m and the capacitor C_E formed by the metal electrodes of the resonator with the quartz as dielectric. For AT-cut quartz resonators in the form of discs with the electrodes occupying only part of the surface area, C_E is approximately 175 C_m. HC-6/U, HC-18/U and HC-49/U style holders all use circular quartz plates of varying diameter, and Equation 2 works quite well with these crystals despite slight variations in the contributions from C_{mount} and C_{case}. The metal case of the crystal under test is assumed to be floating (not held or grounded) in Equation 2, and therefore both of the C_{case} contributions shown in Figure 2 appear in series across the crystal resonator to give an additional 0.6 pF in parallel with C_E for a typical miniature crystal. This accounts for most of the extra 0.95 pF added to C_E in Equation 2, the remaining 0.35 pF coming from C_{mount}. Closer estimates of both C_0 and C_m can be obtained by using Equations 1 and 2 iteratively until reasonable convergence is achieved.

The squat HC-49/US crystals are narrow strips of quartz with the deposited metal electrodes occupying almost all the surface area of the two major faces of the strip. These have a slightly different relationship between C_E and C_m, and a different balance of contributions from the other sources of capacitance towards C_0. However, despite this, Equation 2 still provides a reasonable estimate of their C_0 values. Typically, a 10% error in the value of C_0 will only add 1% to the error in the estimate of C_m using Equation 1, so a rough estimate of C_0 is better than none at all. The capacitance of any connectors or sockets used to hold the crystals under test should be added to C_0 for use in Equation 1. In the past, I've used transistor sockets and pieces of a machined DIL IC socket to hold the miniature crystals being tested. It's advisable to allow at least 0.5 pF for a transistor socket or a section of DIL IC socket, if you can't measure what the capacitance actually is. Quite a few years ago, I was lucky enough to find a TEXTOOL 2-2737 socket on a junk PCB at a hamfest, and that's what I use on my measuring jig now. It's very convenient for holding crystals with wire leads, but adds an extra 2 pF across the crystal under test.

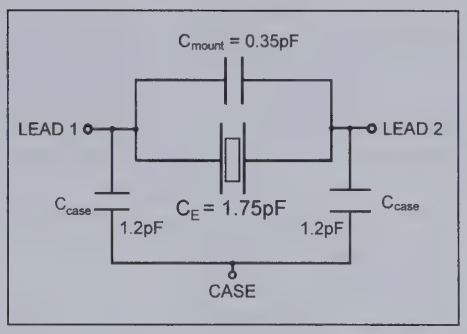


Figure 2—Diagram showing the capacitance contributions made by the case, mount, and electrodes to the overall parallel capacitance, C_0, of a typical 9 MHz HC-49/U or HC-18/U crystal with C_m = 0.01 pF.

Assessment of Crystal Qu

Characterizing mass-produced crystal resonators without assessing their loss in some way is not really an option these days in view of the wide variation in their Q_u values. The frequency-shift oscillator method has been criticised in the past because it doesn't measure crystal ESR or Qu. That's true of the version popularized by W7ZOI, but the author's own version has a means of comparing crystal activity, which is related to ESR and Q_u. You'll already have noticed that the circuit in Figure 1 includes an RF output detector (voltage doubler) using two germanium diodes, D1 and D2, coupled by a 47 pF capacitor to the emitter of TR2. The DC voltage produced by this doubler varies according to the RF voltage swing at the emitter of TR2, which, in turn, is determined by the amount of feedback and the ESR of the crystal under test. It's a pretty obvious thing to do, and I'm sure many other constructors will have done the same. The diodes used in my test oscillators are old Mullard OA47 types, but 1N270 or similar North American types will do equally well. In my original test oscillator a 100 μA meter with a resistance of 1000Ω was connected between points M and G, and used as a voltmeter (100 mV FSD) to detect the RF output level. The potentiometer VR2 was 10 kΩ and allowed the output to be adjusted to give full-scale deflection using the best crystal from the batch, and then the lower RF levels produced by the rest of the crystals were noted for comparison. It's best to use the output readings with S_1 closed, as F_1 is closer to the crystal series-resonant frequency than F_2. Setting the output reading to maximum deflection on the best crystal did require the batch to be checked twice because the best one had to be determined first, but made full use of the limited range of the output meter. Nowadays, I use a digital multimeter (DMM) connected directly to the cathode of D2 with VR2 completely removed from circuit. The increased impedance of the DMM as a DC voltmeter results in a considerable increase in the detected voltage, and the reading is very close to the peak-to-peak voltage swing of the output waveform. This is a lot more convenient than the original arrangement with VR2 and a 100 μA meter.

The RF output of the oscillator is a good measure of the comparative activity of individual crystals providing they are not oscillating so vigorously that all crystals, no matter what their loss, produce almost the same output. You shouldn't have any problems on that score with the Colpitts oscillator in Figure 1, but the output can be controlled to some extent, if needed, by varying the values of C_F and R_E; increasing either reduces the level of oscillation. The converse is also true, of course, but it's advisable not to take R_E below 470Ω and C_F much below 220 pF. I use general-purpose transistors, such as the BC108 and BC182, for TR1 and TR2. The nearest North American equivalent to these is the 2N3904 used by W7ZOI. Comparing relative output levels is a very quick and reliable means of determining the best crystals from a batch. For a given set of crystals, all with nominally the same electrode area, the higher the output level a crystal gives, the higher its Q_u. So, crystals just need to be checked for output level as their frequency shift is measured and the voltage reading for the lower frequency, F_1, noted. The output figures can then be compared later and the higher ones selected for use in a filter. Crystals with large electrode areas will give higher output levels than those with small electrode areas, so HC-6/U crystals will generally give more output than HC-49/U crystals, and

much more than squat HC-49/US crystals. If you find the frequency counter interferes with the level measurement, you might want to add a switch in series with the output capacitor to isolate the counter from the oscillator output during level checks.

"Quick and Dirty" ESR Measurement

Ranking crystals according to the oscillator output they produce is sufficient to be able to select the best crystals for your filter, but if you want to use computer modelling to correct for the influence of loss on bandwidth, then an estimate of ESR or Q_u is necessary. This can be done quite simply with the test oscillator shown in Figure 1, but requires just a little more time and effort than just ranking crystal Q by RF output. If your best crystals have a spread of output levels, try and pair up two crystals from each end of that range with similar output figures (within 5%) and reasonably closely matched frequencies (within 100 Hz). Connect each pair of similar crystals in parallel by soldering their leads together and place them in the test oscillator a pair at a time with S_1 and S_2 closed. The output level should be much higher using a parallel pair than for each crystal alone. Now open S_2 and adjust the variable resistor VR1 until an output level is reached that is equal to the average of the levels previously obtained with the two crystals individually. These individual output levels should have been obtained with S_1 closed, of course. Remove the crystals and check the resistance of VR1 using your DMM. Test points TP1 and TP2 are provided for such measurements and should be feed-through types mounted on the front panel or side of the oscillator box. The ESR value of the two similar crystals in the pair is approximately twice the value of the measured resistance. This method may be very crude, but it will give you an ESR value that is certainly better than 20%, and probably within 10% of the value measured by more accurate means. Once ESR values for the crystals at the extremes of the spread are established, a rough average value can be computed for the set and this can be used for modelling purposes.

Should a more accurate means of measuring crystal ESR be required, there is a description of a simple ESR jig and details of how to modify the test oscillator to make it suitable as a signal source for ESR measurements in the Crystal Filter section (11.6) of the *2010 ARRL Handbook*. It's possible to determine ESR values to better than ±5% with this test set-up if adequate care is taken.

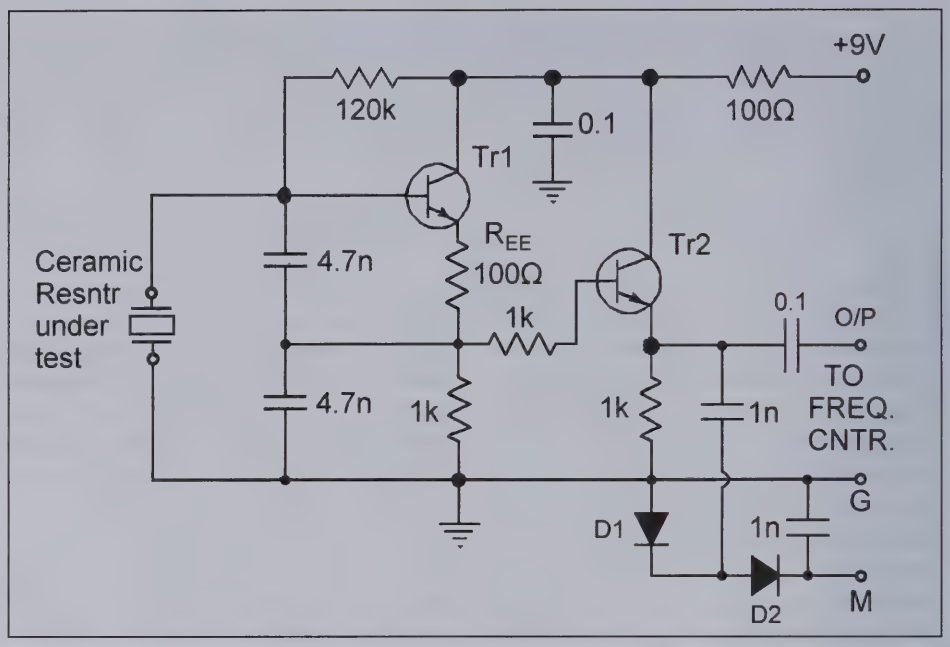


Figure 3—Oscillator circuit suitable for frequency matching and comparing the relative Q values of LF ceramic resonators.

Ceramic Resonator Assessment

Getting ceramic resonators to oscillate reliably in a frequency-shift oscillator can be a real problem. It tends to degenerate into an RC oscillator and go off quite vigorously at low frequencies when the smaller load capacitance is switched into circuit. Ceramic resonators work pretty well in oscillators using logic gates, but the oscillation is often so vigorous that no loss comparisons can be made because their output levels are all pretty similar. However, selecting Murata CSB455E resonators for use in the filter circuits described by the author in a previous article on ceramic resonator IF filters [3] only requires frequency matching and loss assessment, so a switched oscillator to measure C_m is not needed. Figure 3 shows a test oscillator circuit that works reliably with 455 kHz ceramic resonators, but checks them down at a frequency only about 1.5 kHz higher than their series-resonant frequency, which is well below 455 kHz. Despite this, the oscillator allows resonators to be matched in frequency and their quality compared through their relative output voltages.

The level of oscillation can be controlled to some extent by varying R_{EE}, which just happens to be set to 100Ω in my test oscillator but may need to be another value if different devices are used for TR1 and TR2. I used BC108 devices for both oscillator and emitter follower in my circuit, but almost any modern general-purpose bipolar transistor will do. Again, D1 and D2 are germanium types. A pair of miniature crocodile clips make an excellent temporary connection to the resonator being tested, and support it quite well with one soldered to the PCB ground plane. This removes the effect of hand capacitance and heating, which can be a problem if the resonators under test are held in position by hand. I'm sure you can think of other convenient ways to provide a temporary connection if my solution doesn't suit your particular circumstances.

Filter Design Software

There are a number of circuit analysis and crystal ladder filter design packages available these days, and some of them are offered as free downloads on the Internet. One of the better crystal ladder filter design programs is available free from the ARRL Web site [4]. It's called "Dishal" and was produced by DJ6EV and G3JIR. The presentation is excellent, and it's very easy to use. It has the advantage that it automatically corrects for the effect of C_0

on the filter bandwidth. In addition to the series-resonant frequency, it only requires one of the motional parameters of the crystal and C_0 to be entered and computes the other for you. An article describing the program appeared in *QEX* [5], but there are extensive notes with the software so it may not be necessary to read the article before using the program. It doesn't allow for the effect crystal loss on bandwidth, however, so the values predicted by "Dishal" need to be used in conjunction with a separate analysis program to determine the effect of Q_u, and then you can iteratively correct the coupling and termination values to get the desired bandwidth.

Another free program is AADE 4.4 [6]. It's also very easy to use, but is really a suite of programs for network analysis with filter synthesis facilities included. It offers utilities such as six user-defined crystal parameter sets for easy retrieval during the process of entering a new circuit and a crystal ladder filter design facility with all of the common response types included. However, users should be aware that neither the bandwidth compression effect caused by C_0, nor the reduction in coupling caused by crystal loss, are included in the AADE crystal ladder filter design algorithm. To allow for the effect of C_0, you can use "Dishal" or my correction curves described in a previous *QQ* article [7] to determine the values of the coupling capacitors and termination resistance required for perfect crystals (infinite Q). Then, you can use the AADE analysis program, which does allow you to include your average crystal ESR or Q_u, to ascertain the effect of loss on coupling and correct for it.

Modelling is a powerful tool when used in combination with careful characterisation of the filter crystals. It can remove the frustrating and time-consuming trial-and-error phase that often occurs when the performance of a freshly constructed filter doesn't live up to expectations.

Final Remarks

The success of any crystal filter project is heavily dependent on the care with which the crystals are characterized and selected in the first place. Although it's very convenient to use advanced techniques and modern test equipment for better accuracy and convenience, a great deal can be done with very simple homemade test equipment. Indeed, the author used the extremely simple test equipment described in this article to characterize crystals for Butterworth and Chebyshev filters of up to 16 poles during the late 1970s and Linear Phase, Gaussian-Transitional and Bessel 8-pole CW filters in the early to mid 1980s. Starting with the same set of crystals, a filter produced using primitive test equipment can be every bit as good as one where the crystals have been characterised using a computer-controlled VNA, whatever the response or order of the filter. It'll just take a bit longer and require more care and attention to detail. Readers may be surprised to know that the disagreement between the various methods of crystal motional parameter measurement used by professionals is as much as 5%, and simple test methods can very often compete with that.

Spreadsheets are a marvellous way of keeping track of crystal data and manipulating it, so should be used wherever possible. Beginning constructors should not be put off by the apparent complexity of crystal filter design, as it's really not that hard with normalized tables of k and q values. Marvellous results can be obtained with a bit of care. Designing with normalised k and q values is explained in the filter section of any recent edition of the *ARRL Handbook,* as are many of the terms and abbreviations used in filter design work. If you just want to produce a crystal filter for a particular project, though, without learning too much about the underlying theory, then the "Dishal" filter design program, the AADE analysis program, and the author's frequency-shift method of crystal characterisation are undoubtedly the simplest and most convenient way to go. Have fun! That's what it's all about.

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Club Kitting... It's Not a Science Project!

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Okay, you have visited other Web sites and have seen many offers for club projects that are for sale, and the prices are pretty decent. Even the projects seem something you wouldn't mind building as a kit for everything is in one "Bag-o-Parts" so why not buy it? You're always saying, why doesn't our club ever do something like this and produce a project? Well, for one thing, it's not an overnight adventure, and it's not cheap, plus it requires many man hours to just put paper on the table to say you're interested; however, in this article you'll soon be told the secrets to get your club into the world of "RADIO PRODUCTION" and low kitting profits. We at the New England QRP Club did what was required and produced a "club project" that is STILL in circulation 5 years later. The NEScaf filter is working fine with many new and repeat orders arriving each month. Read on and let me tell you more.

There are quite a few steps that have to be followed, and you can't skip any just because you think you're smart enough to avoid the little details. All the detailed steps are required for you to get to the other end of your dreams and have your club benefit the rewards. The first and most obvious step is to have an idea of what you would like your club to sponsor. When I say sponsor, I really mean it's the heart of the club that will get behind the project with energy to get the ball rolling. At the New England QRP Club, Dave Siegrist, NT1U, approached several of the "heavy hitters" in the society of low RF, the NE QRP Club, and asked if building a SCAF filter was worth undertaking. Dave said he had seen versions of his idea in older issues of *QST*, but thought he could make it better and more special. We agreed with him that the idea might be feasible and asked how it was he got this far. It was a project he had worked on first by undertaking and creating a "Manhattan" type protocol, and then making sure it at least worked as he envisioned it. There was no PC board to populate parts because the idea was a rough image in his mind as to what Dave eventually wanted it to turn into. There were scrounged parts from other "dead" projects, wires recycled and ICs from earlier attempts, but it was a working item. Later, his project was tweaked and refined to a point that it was worth telling other club members, so a club decision was now needed. The first word in a club project is—HAVE an idea of what you would like to produce, and make sure it's a working idea.

Assuming you have a working idea for your club project, keep records of what worked and what did not work because this will help you in your final decision to mass produce this item. Utilize the project and know its capabilities to the fullest and what it lacks so you'll have a direction as to how much effort you're willing to support, how much you're willing to spend, and how much the project is worth doing overall. When you have a "working" club project and you believe it's ready for prime time showing, call a meeting and present the working model to the club leaders to show what you would like them to do with it. It's at this point you will gain moment from the club membership to have everyone involved! This is important and will be repeated throughout. Make a group presentation to the leaders of the club and have at least 10 or more present to see what is offered. Produce technical data sheets and notes of your work, and show what worked and did not work. In this appearance, you're seeking club approval for help, time and finances and total commitment.

The first word in a club project is — HAVE an idea of what you would like to produce, and make sure it's a working idea

Ask for ten good, qualified kit building volunteers to take the first step in preparing the project. Give them the needed "Bag-o-Parts" (financed by the club) and ask that they build it, keep explicit notes and return what they accomplished within a certain time period. You may find that perhaps 50% might not build the project at all, which is understandable in today's rushed world, so bear with what you have. It may be built in any format they wish, that is, Manhattan style, ugly, dead bug, floating pads, etc., just to have it built. Remember, there is NO printed circuit board at this time so it has to be done freestyle. The emphasis at this point is to have several kits made, notes compared and a working project working that will later be turned into a full production product.

When several kits have been made and are functioning or not functioning, solicit suggestions as to what needs to be improved, added or deleted. Take all suggestions to improve the project regardless of how technical or trite, and write them down for future use. All improvements made or suggested—some deep and some not so deep—must be considered and documented. An overload of very detailed suggestions might be contributed, so make a priority list and work down the list, avoiding in-depth ideas, and attack from the most serious to the least. You will find that no idea is too simple to leave out. The point here is that no submission is too weak, and all suggestions are to be considered; but not all implemented. There is cost, time and expert technique that comes into play. Each suggestion, one by one, is viewed and agreed upon by the membership. Keep in mind, it's the membership who will be doing the labor in the next few weeks/months ahead.

Now we have come to a moment where a single person MUST be in charge, and this is the project manager. This person will have total say as to how the project will be made, how much money will be spent, and how many kitting parties will be needed to get this club project off the ground. This person will spearhead the entire project and have the FINAL decision as to what will and will not be in the completed club project. If ever there is to be a leader of the band, "Mr. McNamara" is in full charge.

A group-effort schematic is finally agreed upon, and all technical ideas are proofed thoroughly. A proficient PC Board designer guru is brought on board, and a

detailed printed circuit board is successfully calculated to further your project. Commercial PC board houses will do the work for you, however, this is not a free service and requires time and money. The PC board must be tuned, planned and designed perfectly, reflecting your previously drawn schematic. This one event is time consuming but extremely critical, and it MUST be accurate. Physical layout-size for EACH component is measured and placed onto the soon-to-be PC board for exact fit, such as ICs, ground planes, capacitors, resistors, coils, etc. By all means, try to avoid "Jumpers." The PC board needs to have component clearance between items on the board and nothing too close for building ease and total design layout. You will need competent kit builders to work on three boards with in-depth feedback, that is, ease of placement, size and soldering agility, plus the builder's notes of assembly to be transferred to a fabrication manual. At this point of the project, an eye has to be centered on a building manual that will be used as the only connection between club project and the kit builder. All kit builders' notes must be documented and possibly included for future updates.

You're pretty much into the club project at this time, but it cannot be overly emphasized that the project is only as good as the manual that accompanies it. In this day and age of Internet connections, most, if not all, manuals are on line, so it will be an added feature to place your written directions where a kit builder can find them. A location we use at the New England QRP Club is the club's Web site. The technical manual MUST be written in plain English without a lot of "radio" jargon, and all abbreviations spelled out. A technical manual is needed for piecing the project together in a logical and ergonomically desired order. Use check boxes to ascertain how each component is used and numbered steps for the kit builder to follow along with pictures, graphs and figures. This must be written in clear, concise and no jargon phrases with easy reading prose. Skip the technical, in-depth, "look-at-me" background, and save that for the end of the manual or perhaps as a separate file on your club's Web site.

New PC boards will be ordered now that you have successfully debugged your project. There is no need for more protocols, and you're free to order 250 boards on your first order. Deep money is needed to buy all the needed parts and the PC boards to continue your venture. PC boards can be ordered for overnight delivery for a large amount of money and, likewise, for less money longer order time for your PC boards to arrive. Longer time is usually 4 to 12 weeks. All parts are ordered paying CLOSE attention to quantity versus pricing plus the availability of parts from vendor houses. If it is more prudent to order 300 items when only 250 are needed, do it. Save money and use extra parts as spares. When the parts are received, you'll need part bins to store them and The New England QRP Club used plastic (sandwich) storage boxes for EACH component, with covers. These boxes will help in quick transportation and number accountability plus easy access for kitting parties. In each bin, have a 3×5 card to tell quickly how many components are in each. This allows for easy reorder scheduling for later use and ease of answerability.

The fun is now kicking in, and club kitting parties are in order. Have eats (burgers, dogs, pizza), drinks and comfort food for those who help. It is EXTREMELY important that everyone must be serious about the correct part count into each bag of parts for it is more costly fixing a mistake later. Proficient people are needed! Incentives for kitting parties are to have BBQs or pizzas and to give away one or two kits as prizes, etc. Camaraderie is high at the kitting parties, and a great deal of laughter is shared by all who attend. This is the favorite part of a club project and should never be overlooked by having one person fill the bags. Everyone who wants to be included ought to be included, and this goes for the kitting parties.

There are a few unwritten rules that must be followed: only ONE person handles all the money (this could be the club's treasurer and not the project manager); ONE person is P/R (public relations) manager, such as club's Web site, flyers to other clubs, visiting other clubs, etc.; ONE person to handle PayPal accounts, VISA; and ONE person to mail kits to buyers. These, of course, must be responsible people who will perform their jobs without hesitation. There are "Checks & Balances" throughout the entire building process to be sure all monies, kits and components are accounted for. All requests for parts, monies, and help are made public to the entire club with NO behind-the-scene activity. Trust is implicit, and all members in the group work together, which is the key to a club project.

Finally, you're to ready sell your club project; however, you need to set a starting price. Do not go broke creating a club project, but price your kit enough to cover all costs. The labor is free. Mark-up your project, however, not as high as to chase buyers away, for repeat buying is extremely successful and a lower price is BETTER than a one-time high price. Sell at local flea markets, ARRL conventions, and visit radio clubs throughout the area. Advertise! After a lengthy selling period, avoid changes in project design to keep costs down. Avoid "end-of-life" components, and research your project's components to the fullest. That is, if a particular IC is no longer available, locate what would be a desirable second choice. Redesigning is an option but will lead to higher costs. Update the technical manual every time components are changed or procedures have been realigned. Have an on-line download manual at your club's Web site along with price for project and approximate time for delivery. Be sure to give several kits as complimentary prizes when the club meets for your monthly meetings. Good luck and keep the kits coming.

—Dennis Marandos, K1LGQ

About the Author

Dennis Marandos-K1LGQ has been licensed since 1959 when he was a pubescent in grade school as Kn1LGQ, and the thrill continues. He received his BA and Master's degrees in English and has taught English and Basic Electronics throughout his life in public and private schools. Dennis was the past editor for the New England QRP Club newsletter *-72-*, and has written many articles for local and national publications, including national Podcasts. He currently holds an EXTRA class license and is a professor at Daniel Webster College in Nashua, NH teaching technical writing. His favorite mode is QRP CW and operates all bands but especially 40, 30 and 20 meters CW. Dennis lives in Brookline, NH, on two acres of antenna space to keep him active and happy, as well as busy cutting the grass.

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WSPR for Newbies

Pete Juliano—N6QW

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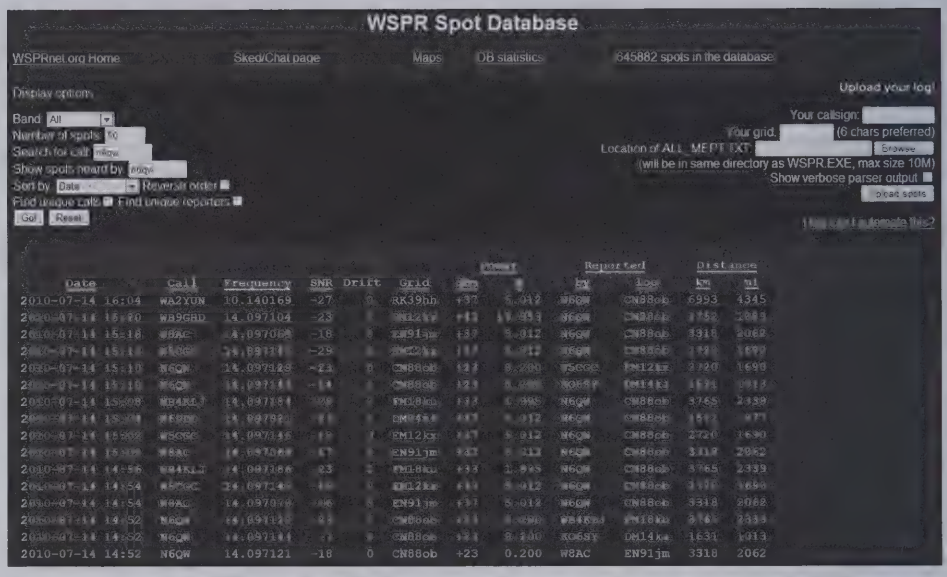
In the course of my experience with ham radio, some 51 years now, events all of a sudden just sort of happen and I am off on some new path. Within the last six months, I have marveled at the many features and capabilities of Software Defined Radios (SDR) and my introduction to WSPR (Weak Signal Propagation Reporting). Here I am again off on a new path!

My exposure to SDR came with a purchase of a gently used Soft Rock V6.2 transceiver for a mere $50. My WSPR exposure of course came about with the excellent article by Preston Douglas, WJ2V, in the Winter 2010 edition of *QRP Quarterly*. WJ2V's article was almost like waving a steak in front of a hungry dog or seeing an advertisement for a new radio that speaks of all the latest bells and whistles. Now that I had an SDR radio, I had to try WSPR. In this article, I would like to share my experiences in what it took to (finally) get WSPR up and running at N6QW. Hopefully, some of the wrong paths I took may be avoided when others set up their stations.

WSPR is the brainchild of Nobel Laureate Joe Taylor, K1JT. The basics behind WSPR are somewhat subtle in that on the surface it may be likened to listening for beacon stations and at prescribed times your station becomes a beacon. Add in the power of the Internet and the information on stations that you have received is uploaded to a database and likewise stations that receive your signal upload the data. The real thrust of the WSPR process is data collection in real time.

The data being collected is available at www.wsprnet.org and can be thought of as a pot of gold! The website has the very latest information about real time propagation by ham band and by number of WSPR participants. The searchable database can be tailored to just your call sign, indicating who has spotted your signal or the stations that you have spotted. Critical data like date and time, call signs, signal to noise ratio (in a 2500 Hz bandwidth), power levels in watts and dBm, frequency drift, grid square locator and the all-important distance (in both kilometers and miles) are shown. See Figure 1. By the way, the first station in the list WA2YUN is on Wake



Fgiure 1—WSPR database.

Island and I live in the Seattle area.

WSPR is not like a regular QSO where one calls or answers a CQ so it may not be for all, especially if you enjoy ragchewing at 35 WPM. But the fun for me is to see how many stations I can spot who are typically running 5 watts or less and how many spot my signal where I frequently am running 200 Milliwatts. I have been spotted at 5000 miles away running only 0.2 watts and that my friend is 25,000 miles per watt. WSPR is a perfect fit with QRP, especially for providing real time data of activity on the various bands. If I see that there are 10 or 15 stations operating on 10M then I may assume the 10M band may be open! Typically the most frequented watering holes are 30M and 20M.

How does WSPR work?

Basically, a station utilizing WSPR will be listening and transmitting on specific frequencies using a computer to control these functions. Note that the same frequency is not used for receive and transmit. The WSPR software has default transmit frequencies but these can be user modified to any frequency within a 200 Hz (yes 200 Hz) band. Typically the listening period is 4 times the transmitting period (80% listen, 20% transmit). WSPR uses Upper Sideband Digital Transmissions on all bands. (One mistake I made was to think that the USB/LSB convention held in the application to WSPR. Early on I had my SDR radio on the 40M WSPR frequencies using LSB and wondered why I wasn't hearing anything.) The computer decodes the WSPR signals and provides a visual display of the information. I can watch the WSPR signals on the waterfall screen of the SDR software I am using and often you can actually see the signal. Many times you barely see a trace yet the signal is received.

So what actually is a WSPR signal (the really behind the scenes working part)? Thanks to G4JNT, Andy Talbot the WSPR coding is given a thorough detailing and explanation. (See http://www.g4jnt.com/Coding/WSPR_Coding_Process.pdf). Well, what else would you figure would be involved with WSPR other than some significant mathematics, which Andy takes you through step by step? Here is what happens

- The WSPR message format includes the call sign, 4 digit locator (grid square), and power level in dBm; the entire message being converted to 81 bits
- A type of error correcting coding called a half-rate convolutional code results in a 162 bit message
- Bits are interleaved to reduce burst of

errors from fading due to propagation
- Encoded and interleaved bits are then randomized using a 162 bit pseudo-random sequence, resulting in 324 bits
- Each two bits become a symbol, transmitted as 4-level FSK modulation. Tone spacing is 1.46 Hz and each symbol is 0.683 seconds long.
- This results in a signal that is 110.6 seconds long and occupies 6 Hz of bandwidth.
- The very low bandwidth allows a high SNR with very little transmit power.
- Error correction coding and bit interleaving reduce the need for extra transmit power to combat fading

Whew, now I think you can guess why I said that behind the scenes there is much going on. But it works and very well!

Setting up a WSPR station.

After reading WJ2V's article, I assumed that setting up a station would be but a few clicks here and a few buttons there and you are done! Well, for me it was not that easy. There were a few glitches, which I will describe here so that others who may want to utilize WSPR will not have such a steep learning curve. As usual, I rushed into the matter without doing some adequate research and reading up on WSPR and the necessary requirements. Thus, I actually think much of the problem was the guy in the cockpit and not the airplane. I have broken the process down into several subsets so that there is some organization to what is taking place and hopefully that will make it easier to implement.

I can only speak to my particular radio set up and thus must apologize that I cannot tell you what you must do to use your K3 or ICOM 756 Pro III or 40M Pixie radio on WSPR. However, most of what I will say applies in some way to many setups. My experience has been limited to three radios: the Soft Rock V6.2 RxTx, the V6.3 RxTx and the SR63ng RxTx (A V6.3 RxTx Surface Mount Clone from Canada). The V6.2 and V6.3 are no longer in production and I am not certain about the status of SR63ng kit. Tony Parks, KB9IYG who was instrumental in providing the Soft Rock kits is currently producing the Ensemble radio, which is the latest version that supercedes the recently retired V6.3 kit. The Ensemble has integrated some of the external functions and connectors in addition to the transceiver into a single board radio that is selling for around $75.

Most likely, if your radio can be put under computer control then it will work with WSPR. Virtually all of the commercial radios of recent vintage have that capability, and if they are sophisticated enough to have a computer control capability then they are probably sufficiently frequency-stable. The WSPR website has a forum available and that would be a great place to make inquiries regarding your specific radio.

In a nut shell, the WSPR requirements demand certain capabilities that would pose a challenge to an older vintage or older technology radio. Chief among those requirements are frequency accuracy and stability. WSPR has designated specific frequencies in each of the amateur bands and all WSPR transmissions occur within a 200 Hz bandwidth around that frequency. These frequencies are shown on the WSPR website and as a part of the WSPR set up. Frequency accuracy is required because many stations may be active in the small WSPR operating band. To reduce interference, transmitted frequencies are chosen by a WSPR operator to be different from the frequencies of other active WSPR stations as reported by the WSPR website. As the WSPR signals are only 6 Hz wide, the transmitting frequency need only be separated by about 8 to 10 Hz from active stations and frequency readout accuracy of 1 or 2 Hz is needed. Excellent frequency stability is needed because of the low bandwidth and corresponding slow baud rate of the WSPR signal. Ideally, the transmitter should not drift more than 1 Hz over the 110.6 seconds required to transmit a WSPR signal. However, a small amount of drift, on the order of a few Hz, can be corrected in the WSPR software. For longer measurement periods, frequency drift should be random with no up or down drift in a single direction. Otherwise, frequency accuracy will be affected. That sounds like your favorite homebrew regenerative radio may not work too well in this application. I cannot overstress these two factors: accuracy and stability. Generally, either crystals or a good synthesizer must be used to set frequencies.

The remaining major requirement is to make accurate time-of-day available to your computer software. The reason for this requirement is best described using the WSPR process sequence of events. Your radio must be first tuned (precisely) to the pre-designated frequencies. The WSPR software is then initiated and will wait for the next even minute before actually starting. Say you initiate at 17:04:20Z (17 hours, 4 minutes and 20 seconds UTC). The software will not actually start until 17:06:00. Once started the WSPR software typically will go into the receive mode for two minute periods where any WSPR signal heard will be decoded. Transmissions from your own station are repeated at intervals that are a multiple of the receive periods, with the multiple set by the operator. Typically, transmission intervals are set so that your station transmits 20% of the time. However, at times I am far more interested in seeing what I can hear so I may set the TR ratio to 5% and 95%. When it does come time to transmit, the computer/software takes over and switches off the receiver and routes the signal to the transmitter where the WSPR signal is transmitted for approximately a 2 minute period. At the end of that time, the computer/software takes control and reroutes the signals back into the Rx mode for further decoding of received signals. Any signals heard are usually uploaded to the WSPR database via the Internet. Regardless of the transmit percentage chosen, the transmit interval is varied randomly by a small amount so that all stations are not listening all at the same time and transmitting at the same time otherwise nothing would be heard. As you can now see from the description above, successful operation of multiple WSPR stations on the same band requires that all of the station computer clocks have access to accurate time. Otherwise, collisions between WSPR signals would increase dramatically. To prevent this occurrence, your computer clock must be "spot on" to within 1 second of a GMT standard. Several software programs are available to help you achieve this accuracy.

Now I will tell you how the above operational requirements translate into hardware and software.

Computer Requirements:

- The computer I am using (homebrew) is also used for the SDR radio which means it must have reasonable speed (>2 GHz), sufficient memory (2 GB),

an OS such as Windows XP or better, and an Internet connection.

- The Sound Card is the Delta 44, which is a Supported Card that is required by the Power SDR IQ software (V1.19.3.15) I am using. Other supported cards will work, as will some of the unsupported cards. I had a lot of grief over sound cards until I quit using an unsupported card and installed the Delta 44.
- Serial Port or Virtual COM Port (I am using a Virtual COM Port pair)

Hardware requirements:

- A transceiver or receiver so long as it is stable and accurate to within a few Hz
- Frequency drift less than about three Hz over the 2 minute transmit cycle
- Receiver/Transmitter or Transceiver must be capable of computer control
- A simple dedicated receiver/transmitter may have operational advantages especially if one is to leave WSPR running continuously.
- Rx only operation is possible if you only wish to report WSPR signals you hear.
- The power source must be clean and free from hash and noise. (I recently built the V6.3 and the SR63ng transceivers. I was baffled because my transmitted signal was being heard world wide, but I was hearing very few stations and only those who were running 10 watts or more. Then the light bulb went on! I was using a switching power supply and the Soft Rock transceivers are essentially direct conversion receivers that are prone to noise and hum. The hash from the "el cheapo" switching power supply was masking the weak signals. Putting the radios on my stiff homebrew linear supply dropped the noise floor and suddenly I was hearing the weak signals. So take note about the power supply being used)

Software requirements:

- There are four separate pieces of software, excluding the OS, that are used in my WSPR set up. The first is Power SDR-IQ V2.0 (V1.19.3.15) which is available free from the following download site: http://code.google.com/p/powersdr-iq/downloads/list.
- The second is Com0Com, which is software to enable establishing pairs of virtual communications ports on your computer. This may be downloaded free form the following site: http://sourceforge.net/projects/com0com/.
- The third is Virtual Audio Connection VAC 4.09. Essentially this software controls the internal routing of the signals over the virtual communications ports. This software must be purchased and the cost is approximately $30 and see: http://software.muzychenko.net/eng/vac.html VAC 4.09 must be used
- The last is the WSPR software available free from the following download site: http://physics.princeton.edu/pulsar/K1JT/.
- If not already included with your computer you must also install software that will automatically update your computer clock over the Internet. Your clock must be accurate within 1 second.

Figure 2—VAC and drive level setup in Power SDR.

Now that you know what parts are required, we can put the station together and actually get it working. Here are the steps as I actually performed them. But before you get started, it might be a good idea to go to the K1JT website and review the WSPR User's Guide there. It is a good, quick outline of the necessary steps. Also, please note that Flex Radio has a Knowledge Base paper that describes the steps and how to set up these elements so that the radio will work with WSPR. See http://kc.flex-radio.com/KnowledgebaseArticle50230.aspx.

Start by acquiring and loading all of the software as some of the set up steps will require other software to be loaded on your machine. Next if using the Soft Rock radios set up the Power SDR so that the radio is functioning as a radio. Once that is done, there are two particular sets of Power SDR tabs that require attention to make WSPR work. When the Power SDR V1.19.3.15 SV1EA commonly known as V2.0 is opened, at the top of the panel is a link marked Set Up. (See Figure 2.) Clicking on that brings up the Set Up panel.

Two tabs in particular on that pane will be used for this part of the set up: the Audio Tab and CAT Control Tab. Click on the Audio Tab and there are two sub-tabs one marked Primary and the other marked "VAC". Select the VAC tab and make the entries as shown in Figure 3. You will note that earlier I indicated the necessity to download and install of all the software. If you have not done this then the selection you see in Figure 3 will not be present. Next go to the tab marked "CAT Control" and make those entries. See Figure 4. Removing the check mark in PTT will give you access to the selections that are greyed out. Make those entries and then check PTT. These actions accomplish two things: in the first case it is giving routing instruc-

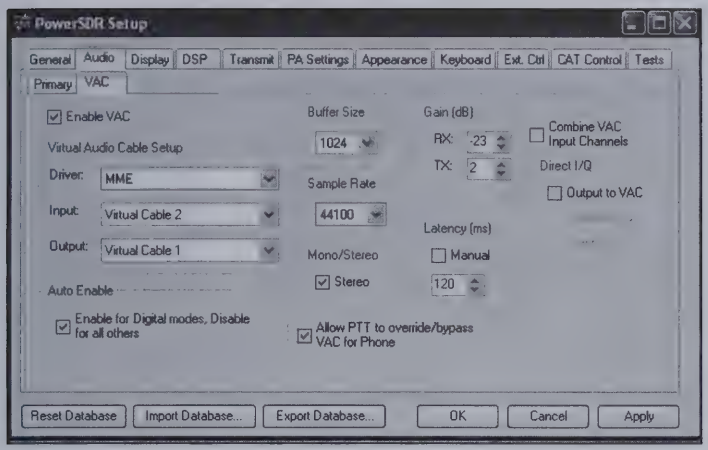


Figure 3—VAC Tab setup.

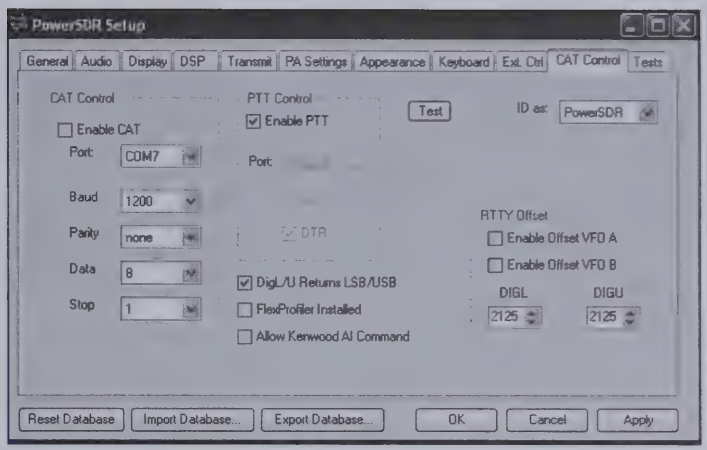


Figure 4—Control Tab setup.

tion for the Virtual Audio Connection and in the second it tells the method of turning on the transmitter (CAT or PTT) and the virtual COM Port where the transmit information will be sent. This is where it is important to jot down what you have done, for this information is used in other parts of the set up with other software. Failure to do this on my part caused a lot of wrong information being entered in some of the software

A note here about the VAC Tab in the Power SDR Set Up. In other set ups, the Virtual Cable 1 and Virtual Cable 2 will be crisscrossed so that while the Virtual Cable 1 is on the "output side" of one piece of software will become the "input side" of another and the same goes for Virtual Cable 2. In my Power SDR, the input is Virtual Cable 2 and the output is Virtual Cable 1.

On the CAT Control Tab, note that COM Port 18 has been selected. That was by design and that specific number selection was a part of the Virtual COM Port Pair set up with the Com0Com software. This COM Port selection will also be used in the WSPR software set up. The other selections, DTR and RTS, are similarly used with the WSPR software. [In case you are wondering DTR stands for Data Terminal Ready and RTS is Request To Send, both of which are standard pin outs for the RS-232 serial communication interface.]

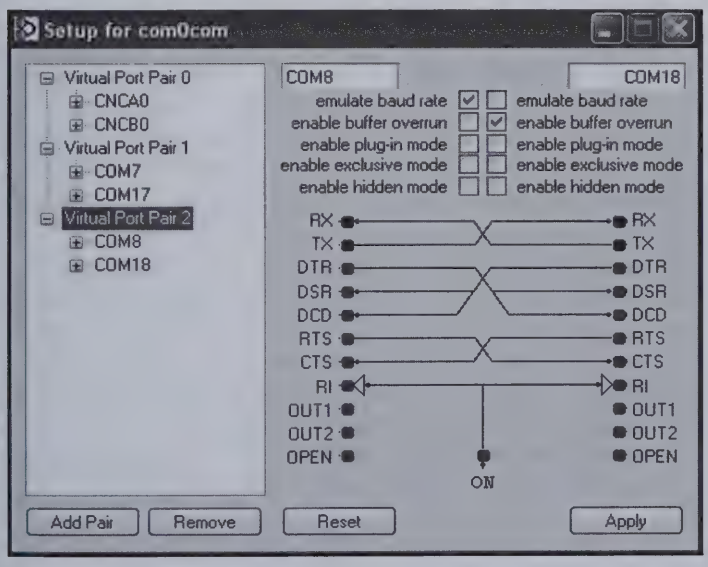


Figure 5—Com0Com Set Up Panel

The Com0Com software is relatively easy to set up and this can be seen in Figure 5. Simply add the pairs you want and the number system you want. I created two pairs 7 and 17 and 8 and 18. For this application I chose 8 and 18. I think that perhaps this visual depiction is helpful in understanding how the signals are internally routed in the software. Note the entries that are check marked. Note also the DTR and RTS, which were previously mentioned.

The Virtual Audio Cable Set Up is shown in Figure 6. (This can also be seen in the Flex Radio Knowledge Base document that was referenced earlier.) This software must be purchased from the author and be sure to use Version VAC 4.09. (There are some issues with Version 4.10.) The author has supplied a free trial version on his website. Superimposed over the software is an audio signal that essentially says "Trial". Using this version will not work with WSPR. You must have the clean (read: purchased) version.

Next is the actual set up of the WSPR software and there are two specific panels that must be addressed. The first is the Set Up panel shown on the upper task bar. See Figure 7. This is where the data mentioned earlier in how WSPR works, must be entered. The first is your call sign, next is the grid square information. You can find your grid square by visiting http://www.qrz.com, and looking up your call sign. One of the blocks on the call sign information shows your grid square.

Also take a moment to correct your actual physical location on the map. I will not go into that detail but information is available on QRZ.com on how to do that. You will find that the WSPR

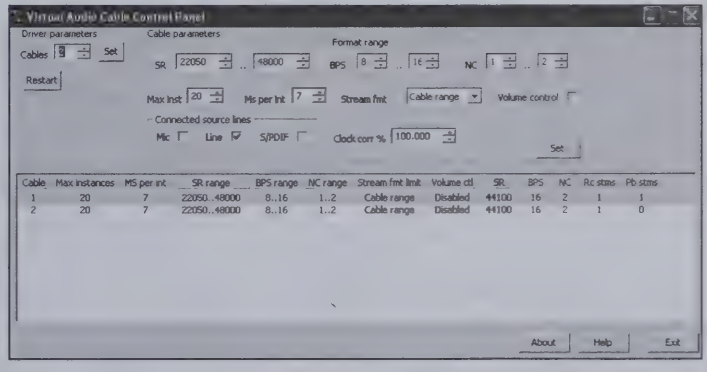


Figure 6—VAC 4.09 Set Up Panel

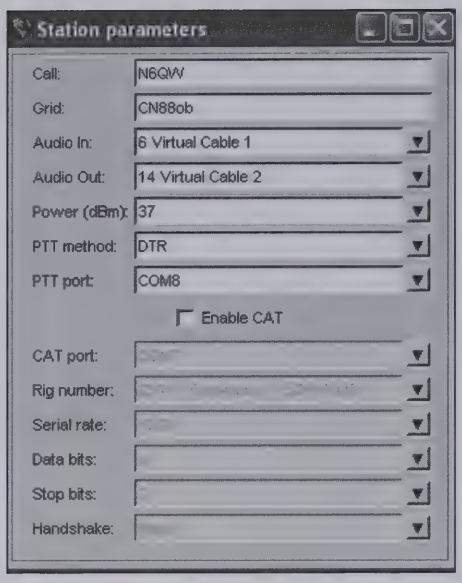


Figure 7—WSPR setup.

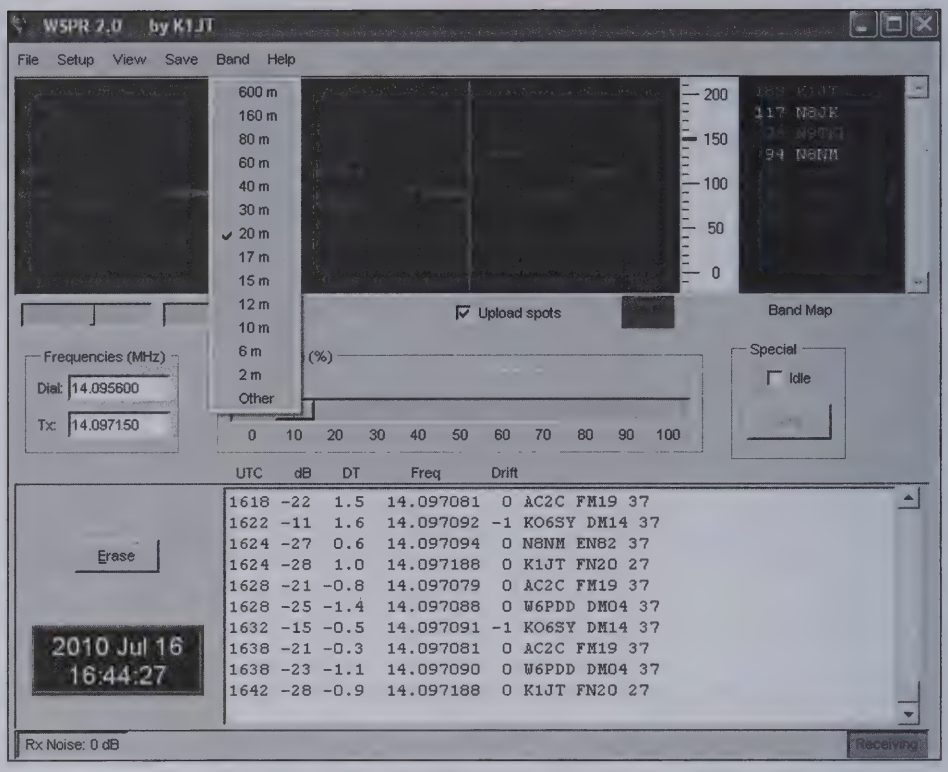


Figure 8—WSPR band setup.

homepage contains a map of the world showing all of the stations currently using WSPR. The map uses the QRZ database as one of its sources. So if you want to show up correctly on WSPR you need to fix the QRZ location. Until I did that I was shown about six miles from where I actually live.

Now to the audio cable routing set up. This is where the "input" of one is connected to the "output" of another. Refer back to Figure 3, and you will see the "output" of the SDR VAC is on Virtual Cable 1 and the "input" of WSPR is Virtual Cable 1. This is why I stated earlier to write this information down so you have it correct. I chased this problem for a whole two days until I realized I had the "in to the in" and the "out to the out"!

Now I would like to discuss power levels and how to input the information into the panel. There are actually several stations running 100 watts. Joe Taylor, K1JT is frequently spotted running 0.5 watts. It seems that most stations are running 5 watts. I have been running 200 milliwatts with occasional excursions to 1 watt. My impression is that something around 1 watt is plenty to enable world-wide communications. But that is just my opinion.

Once you have decided on a transmit power level, you must convert this level to dBm for your WSPR data message. (dBm is a relative power measurement as compared to 1 milliwatts or 0.001 watt). If making this conversion is unfamiliar to you, then consult any recent *ARRL Handbook* for a short discussion on converting from watts to dBm.

Next is the keying method and that is shown as DTR (Data Terminal Ready. Remember the CAT Control Panel in Power SDR and the blocks that would be checked)

Finally is the COM Port. You will recall that the Com0Com established COM port pairs which in my selection was 8 and 18. The Com Port selected in Power SDR was COM18 and so the matching pair for WSPR is COM8. Again, this took me a day or two to sort out which COM port should be where.

One additional set up in the WSPR panel is the Band Information see Figure 8. This particular set up feature has given me fits and starts! It is a simple click on the item and you are done! But when you physically change bands such as going from 20M to 30M you also need to manually change the band information otherwise you will be reporting data with the wrong band information. The frequency data is recorded based on where you have the band selection in WSPR. This caused a bit of a stir recently where a US station reported a DX station using the wrong band info. Seems like the DX station would not have privileges in the band reported. So there was a scramble to get that corrected. That is another "Gotcha"! The default transmit frequencies are in the middle of the 200 Hz band. It is a wise idea to move your transmit frequency to something other than dead center, + or – 25 Hz is a good starting place. Simply go to the block marked Tx along the left-hand edge that shows the transmit frequency and enter a new value there. You will note my selection is 14.097150 MHz, which is 50 Hz above the nominal 14.097100 MHz default frequency.

Also see in Figure 8 the slider control in the middle of the screen, which is somewhat obscured by the drop down band information. The slider control, where you can just barely see the % sign sets the ratio of transmit time to receive time. Setting that value to Zero (0) means that WSPR will be in a receive only mode!

We're getting close to being done, but a couple of more adjustments are necessary in the Power SDR Panel. See Figure 2. These adjustments include setting the drive level, and the receiver noise level. This is where it is necessary to simultaneously open the Power SDR Window and the WSPR Display Window. I typically minimize both windows so the WSPR window overlays on the Power SDR window. But for this adjustment the critical part is to

observe the lower left-hand corner of the WSPR window to see the Rx Noise level while manipulating the Rx Slider in the VAC sub-panel in the Power SDR window. Adjust the slider until the Rx Noise level is at 0 dB. See Figure 9. Another noteworthy adjustment is the sample rate in the VAC panel, which I have set at 44100. This is the same rate I used in the VAC 4.09 set up. Look also at the Drive level along the left-hand edge of the Power SDR panel as this is where you will adjust your power output level.

Relative to power output level, I have used an oscilloscope to measure peak-to-peak levels and using the formula (p-p)^2 divided by 400 and this value multiplied 1000 gives the power output in milliwatts. This assumes a 50 ohm load. If you get 20 volts p-p that corresponds to 1000 milliwatts. For 200 milliwatts then the p-p reading must be about 9 volts. For 500 milliwatts the reading should be 14.1 volts p-p. Using these values, I have a homebrew SWR Bridge that I use and have tick marks on the power level pot to set the power levels in the forward reading that match these readings.]

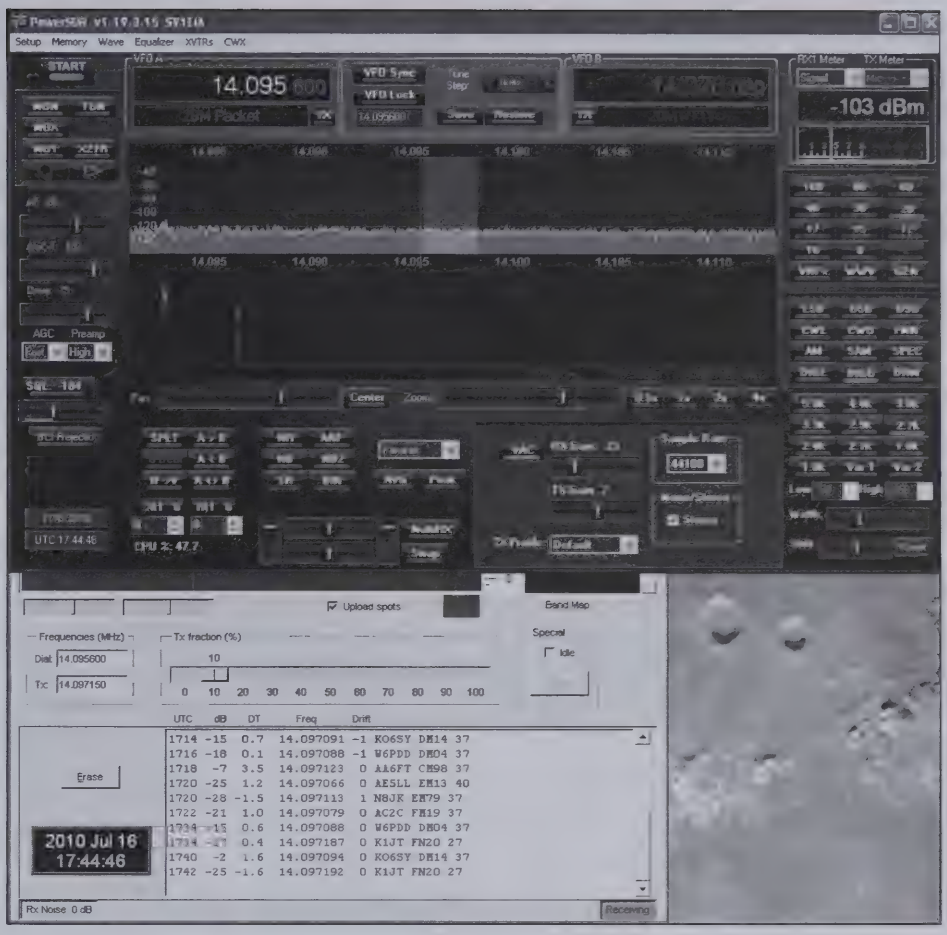


Figure 9—Receiver noise level setup.

The End (or beginning) of the Path

Figure 1 is from the database and displays the typical information that is being gathered. You will note that most of the signal to noise ratios are relatively small (-26 dBm as an example). Translated, that is like someone whispering on a crowded street. But the information is copied thanks in large measure to the computer data processing and the very narrow bandwidths.

It took in aggregate about a week to set up my WSPR station which in large measure I attribute to my "older technology" self. I don't Twitter or Facebook and I can barely send text messages consisting of one or two words. So one should take my experience as not typical to those who have grown up with computers, software, and virtual COM ports. But now that I have it working, it was a worthwhile learning experience.

But I truly marvel that I have been heard world-wide and I too have been able to copy (or should I say my computer can copy) those same stations. I think the key to a successful set up rests with getting a good grounding with the many resources that are available. The Flex Radio Knowledge Base was most helpful, as was the paper by G4JNT on how the WSPR data stream was developed. I wish to extend my thanks to Bob Reeves, G8VOI who also helped me during the course of setting up WSPR. Bob's tutorial on how to put the Soft Rock precisely on frequency can be found here. http://home.ict.nl/~fredkrom/pe0fko/g8voi/PE0FKO%20SoftRock%20AVR%20Firmware%20User%20Guide%20Issue%201_1.pdf

A word about whom I have spotted and who has spotted me. I have been spotted in the following countries (virtually all on 20M): Japan, Spain, Germany, UK, New Zealand, Chile, Brazil, Belgium and Norway. Most were at 1000 milliwatts and at least one at 200 milliwatts. If you were to put this in the context of "what is your best DX?" then I would have to say the 7400 Mile spot in New Zealand! Needless to say I have similarly spotted the same locations with a few others thrown in for good measure.

A majority of my spots have been stateside and that has been mostly when there is very little activity on SSB or even CW. I suspect that many hams have been listening on the SBB and CW portions and assumed it was a dead band, when in fact many are just not getting on the air. WSPR is a tad bit different as it can run almost unattended and just plain listens! It is simply amazing. That said, I do find that when I am spotting many stations very early in the morning that translates into good band conditions. The WSPR database is "hard data" that gives some startling results. Signals are being heard far and wide. That certainly should signal that QSO opportunities abound—just get on the air. Or like me, try a new path!

—72/73, Pete, N6QW

■■

Erratum from the Summer 2010 Issue:

Pete, N6QW also wrote the article "SDR for Newbies" in the Summer 2010 issue of QQ—but the editors messed up his e-mail address! Readers should note that the correct address is given with this article: radioguy90@hotmail.com

Selecting the Right Gel Cell for Portable QRP Operating

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Most of us own at least one of the convenient sealed lead-acid (SLA) "Gel-Cell" or Absorbed Glass Mat (AGM) batteries used to power all sorts of gear. They're great for stowing in a backpack or car for a weekend's operating in the great outdoors, and their self-discharge rate of around 3-5% per month is much lower than NiCd or NiMH batteries which discharge at around 20% and 30% per month respectively.

This article arose from a need to find an easy way of matching a gel cell battery to a solar panel, but the more I experimented and read about these batteries the more I realised they warrant a separate discussion of their own. I hope to provide a follow up article with the solar panel findings in a future *QRP Quarterly*.

Great as they are, gel cells do have quirks that you need to be aware of, otherwise your portable operating could unexpectedly terminate early, or you could be dragging more lead up a mountain than you need to!

A good starting point is to examine the ampere-hour (Ah) rating of a battery. Is it telling you the truth? Well, yes and no.

Discharge rates.

An amp-hour (Ah) is the term used to express the storage capacity of deep cycle batteries. One Ah is simply the flow of one amp for one hour. So the flow of half an amp for one hour is simply 0.5 Ah, or 500 mAh, and so on. Manufacturers assign battery ratings by discharging them to 100% depth of discharge (DOD) over a set period of time. This is usually—but not always—twenty hours, and is known as the "20-hour rate". Thus a 40 Ah battery (at the 20-hour rate) can deliver a continuous 40/20 amps, or 2 amps, for twenty hours before the terminal voltage reaches 10.5 volts. Intuitively, you might assume that the same battery could deliver twice the current for half the time, or four times the current for a quarter of the time and so on, but it won't. This non-linearity arises because as load increases, battery capacity decreases, and vice versa.

The 20-hour rate, as indicated by the gray line in Table 1, represents the only combination of conditions where a manufacturer's specified Ah rating will actually be achieved: that is, when discharged to 100% DOD over 20 hours at a temperature of 77F/25C. Discharging for any other period or at any other temperature causes the Ah rating to change.

Using Table 1, suppose we fully discharge a battery in ten hours. Select "10" in column one, and in column two read off the percentage of the 20-hour rating which must be applied, in this case 94%. In other words, we're effectively de-rating the battery by 6%. Conversely, discharging over 30 hours actually increases capacity by 4% to 104%.

Discharge Period (hrs)	% of 20-hour Rating Capacity	Battery Temp (F/C)
50	111	110/43.3
45	109	104/40
40	107.5	98/36.7
35	106	92/33.3
30	104	87/30.5
25	103	84/29
20	100	77/25
19	99.5	76.5/24.7
18	99	76/24.4
17	98.5	75 / 24
16	98.25	74/23.5
15	98	73.5/23
14	97.5	73/22.8
13	97	70 / 21
12	96	66/19
11	95.5	65/18
10	94	62/17
9	93	60/15.5
8	92	58/14
7	91	55/13
6	89	50/10
5	87	45/7
4	84	41/5
3	82.5	40/4
2	75	25/-4
1	68	15/-9

Table 1—How Gel Cell/AGM battery ratings change according to different discharge rates and battery temperatures.

Temperature Effects.

A battery's Ah rating also changes when it operates above or below 77°F / 25°C. Below this temperature, a battery's capacity decreases, while above it capacity increases. But don't think this means hotter is better. While keeping an SLA battery cooler generally prolongs its life, a hot environment will shorten it due to increased rate of grid corrosion of the positive terminal. As an aside, it is this grid corrosion that is responsible for the relatively low number of charge/discharge cycles of an SLA compared to other types of battery. As a general rule, for every 15°F / 8°C rise in temperature, battery life is halved. So if a battery lasts ten years at 77°F / 25°C, it would only be good for five years if used at 95°F / 33°C, or barely two years at 107°F / 42°C.

When accounting for temperature, use Table 1 in exactly the same way as for discharge rates except this time use column three to read off the corresponding de-rating to be applied. Note that change in rating with temperature is almost linear unlike with discharge period.

General Considerations.

All figures in this article are a guide only: there is nothing exact when dealing with batteries. Having said that, the data provided here will give a good indication of how a battery typically performs in "real life". There are also several practical examples relevant to QRP operating.

It is also important to check manufacturers' data sheets. They are usually freely available online and often provide a huge amount of valuable information about charging/discharging, correct voltages, currents and so on.

Also keep in mind that Table 1 is based on discharging gel batteries at a continuous rate [1] until they are dead i.e. 100% DOD, but repeatedly taking them down this far severely shortens their lifespan. The number of achievable cycles based on depth of discharge is typically:

- 150-200 cycles at 100% DOD
- 400-500 cycles at 50% DOD
- 1000+ cycles at 30% DOD

Many deep cycle battery manufacturers recommend no more than 50% DOD, which is a compromise between battery life, capacity and cost. But discharging to 50% effectively limits use to only half the Ah capacity available, or more if you don't normally take a battery to 100% DOD. In real life, discharging to 80% is a good compromise and is unlikely to damage a battery. If using this depth, it would make sense to add around 20-25% to the Ah rating you come up with in any calculations based on either Tables 1 or 2 to make up for the reduction in capacity you are imposing on yourself. Similarly add around 50% if it's a priority to maximise your battery's life by discharging it to only 50%. For this article, all calculations are based on Tables 1 and& 2: discharging to 100% DOD. It is left to the reader to adjust the recommended capacities according to the chosen DOD that you are comfortable with.

Putting Theory into Practice.

It's time to start looking at the real world and I'll begin with a Table 1 example combining discharge rate and temperature effects. Scenario: Discharging a 7 Ah battery over six hours at 25°F / –4°C. What is the effective battery Ah rating under these conditions?

1. Go to the six-hour discharge period (the "6-hour rate") in column one and read off the corresponding figure in column 2: 89%.
2. Now, 89% of 7 Ah is 0.89 ×7 = 6.23 Ah.
3. In column three, go to the 25°F / –4°C entry and read off the corresponding figure in column two, which is 75%.
4. Now take 75% of 6.23 Ah to obtain the final capacity figure of 4.7 Ah.

This means that a 7 Ah battery behaves like a 4.7 Ah battery when fully discharged over six hours at 25°F / –4°C.

Determining Power Consumption.

The next step in choosing the right capacity battery is to check what current your rig consumes and what type of operating you plan to do with your portable setup. Suppose I take my Elecraft K1 for six hours of casual operation on a hilltop. In receive mode, it draws a lean and mean 60 mA while in transmit, current draw is around 620 mA at 5 W output. Now, in every hour I listen for about 75% of the time and transmit for the remaining 25%. Therefore average current consumption per hour will be:

Receive: 0.06 A × 75% = 0.045 A (45 mA)
Transmit: 0.62 A × 25% = 0.155 A (155 mA)
Receive + Transmit = 200 mAh.

Now consider current draw if you're planning for Field Day. The receive to transmit ratio will be different, say 60:40. Reworking for the average current consumed:

Receive: 0.06 A × 60% = 0.036 A (36 mA)
Transmit: 0.62 A × 40% = 0.248 A (248 mA)
Receive + Transmit = 284 mAh

Average current drawn (Amps)	Battery duration, hours (at 78F/25C)				
	3 Ah	5 Ah	7 Ah	9 Ah	14 Ah
0.1	30	50	>50	>50	>50
0.15	20	35	50	>50	>50
0.2	14	25	35	45	>50
0.25	12	20	25	35	>50
0.3	9	16	23	30	50
0.35	8	13	20	25	40
0.4	6	12	17	23	35
0.45	5	10	15	20	30
0.5	5	9	13	17	28
0.55	4.5	8	12	16	25
0.6	4	7.5	11	14	23
0.65	-	7	10	13	21
0.7	-	6	9	12	20
0.75	-	5.75	8.5	11	18
0.8	-	5.5	8	10	17
0.85	-	5	7.5	9.75	16
0.9	-	4.5	7	9	15
0.95	-	4.5	6.5	8.5	14
1.0	-	4	6	8	13
1.05	-	-	6	7.5	12.5
1.1	-	-	5.5	7.5	12
1.15	-	-	5	7	11.5
1.2	-	-	5	6.75	11
1.25	-	-	4.5	6.5	10.5

Table 2—Approximate battery durations for different capacity batteries based on typical QRP current consumptions.

That's over 40% extra battery capacity required. It's also worth noting that if operating CW or SSB, the transmit duty cycle will be lower, around 50%, so total current figures would be less. But if you're taking part in a PSK31 contest with a transmit duty cycle of 100%, the figures above will be close. Don't get too hung up on precision, just something to bear in mind.

Once current draw requirements are known, Table 2 can be used to estimate battery durations for different capacity batteries. The 20-hour rates for individual capacities are again highlighted in grey: below this rate capacity is reducing, while above it, capacity is increasing. Table 2 can answer quite specific questions:

1. "How long can I draw *x* amps with a *y* Ah battery? ... or, put another way: "How long will my *y* Ah battery sustain *x* amps?" And coming at it from a different angle, we could also ask:
2. "My rig and accessories draw a total current of *x* amps. I want to operate for *z* hours. What's the smallest capacity battery I could use?"

Using Table 2

Referring back to the K1 drawing 200 mAh, locate 0.2 A in Table 2, near the top of column one. To the right, see that any of the batteries listed will power the rig for many hours, from fourteen hours with a 3 Ah battery to over fifty with a 14 Ah.

On the other hand, an IC-703 or FT-817 consumes around 800 mAh in casual operation. This time, locate 0.8 A in column one but note that the first box to the right contains a dash instead of a figure. This indicates that the recommended maximum discharge rate of 0.2 times the stated capacity (0.2 C or C/5) for a gel/AGM battery would be exceeded and could result in noticeable voltage drop. "C" is a common way of specifying a battery's charge/discharge current and is the charge or discharge current divided by Ah rating. In this example, the table shows two things:

(a) Using less than a 5 Ah battery is not recommended for supplying 800 mA; the discharge rate is around 0.3 C and would only give around 3 hours of operation, whereas
(b) A 5 Ah battery will keep the same rig powered for around five and a half hours with a discharge rate less than 0.2 C.

Table 2 Examples.

Example 1. "I have a 7 Ah battery and my rig draws an average of 750 mA in normal operation. How long is the battery likely to last? (assume 77ºF / 25ºC)"

1. Find 0.75 A in column one;
2. Move across until you intersect the 7 Ah column;
3. The figure you see (8.5) corresponds to the battery duration of around 8-1/2 hours.

Example 2. "My rig, keyer and LED lamp draw 1 A. I want to operate for eight hours. What is the smallest capacity battery I should take with me?".

1. Find 1 A in column one;
2. Move right until you see a duration of eight hours, or as close as possible;
3. Read off the corresponding battery Ah rating, in this case it is 9 Ah.

As I mentioned earlier, you should now add a percentage to this capacity to compensate for the depth of discharge you normally use. I like 80% DOD so I add 20% and take an 11 Ah battery, But if you're ok with 100% DOD or close to it, then you're good to go with 9 Ah!

Example 3. Here's a final example, with a slightly more complicated scenario: "I want to operate for seven hours from a local hilltop in January. My rig and keyer draw 600 mA (0.6 A). The temperature is going to be around 25ºF / –4ºC. What gel cell do I need?"

1. From Table 2, find 0.6 Amp in column one;
2. Look right to find a "7". If it's not there, go with the closest match, here 7.5 hours with a 5 Ah battery;
3. Now account for the low temperature by de-rating the 5 Ah capacity for 25ºF / –4ºC, which from Table 1 is 75% of capacity, leaving 3.75 Ah effective capacity;
4. With only 3.75 Ah effective capacity, we're going to be lacking in current [2]: 3.75 × 91% / 7 = 488 mA
5. Ok, we could operate for five hours with this "3.75" Ah battery: 3.75 × 87% / 5 = 653 mA…
6. …but if you really need to operate for seven hours, then you'll need a bigger battery. Let's try 7 Ah. From Table 2, under normal conditions, this would provide 11 hours at 600 mA. De-rating again for temperature gives a 5.25 Ah equivalence (7 Ah × 75%) capable of delivering just under 700 mA at a 7-hour rate (5.25 × 91% / 7). Thus a 7 Ah battery would be a good choice in this scenario. Would a 6 Ah battery suffice? I'll leave that for you to check in exactly the same manner!

And a final plea: always keep the open terminal voltage of your gel cells at or above 12.6 V and don't discharge them beyond 10.5 V (11.7 V open terminal). Good luck, and may the (electromotive) force be with you.

Notes

[1] An intermittent discharge allows a battery to "recover"somewhat, but for the purposes of this article we assume a continuous battery load typical of portable operation.

[2] Using the formula: Current = (Ah) × (% of 20-hr rating) / (hour-rate)

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The Kits and Parts DDS Board

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I seem to be a sucker for synthesizer projects. Their low cost, relatively clean output, and frequency accuracy and resolution make them perfect for rig VFOs, local oscillators or general purpose workbench signal sources. Plus, they're a fun project for programmers to attack when supplied without any controller, as is often the case. I've built the NJQRP DDS-30 and DDS-60, a limited edition run by Trevor, K6ESE, plus a Si570 PLL synthesizer on the same form factor card as the NJQRP boards, to name a few. I'd been checking out this one on the website and when I saw Diz demonstrating it at FDIM I had to give it a shot. This is a 30 MHz (maximum) synthesizer using the AD9834 chip.

The Kits and Parts board takes a different approach from the bare bones units in that it incorporates just about all of the additional hardware and software needed to make it a stand-alone synthesizer. In addition to the usual DDS chip, filter and reference clock it also includes:

• A programmed ATMega88PA microcontroller (MCU) to control the DDS chip. This is a 28-pin chip with at least eight uncommitted pins that the user could use for rig control or other functions.

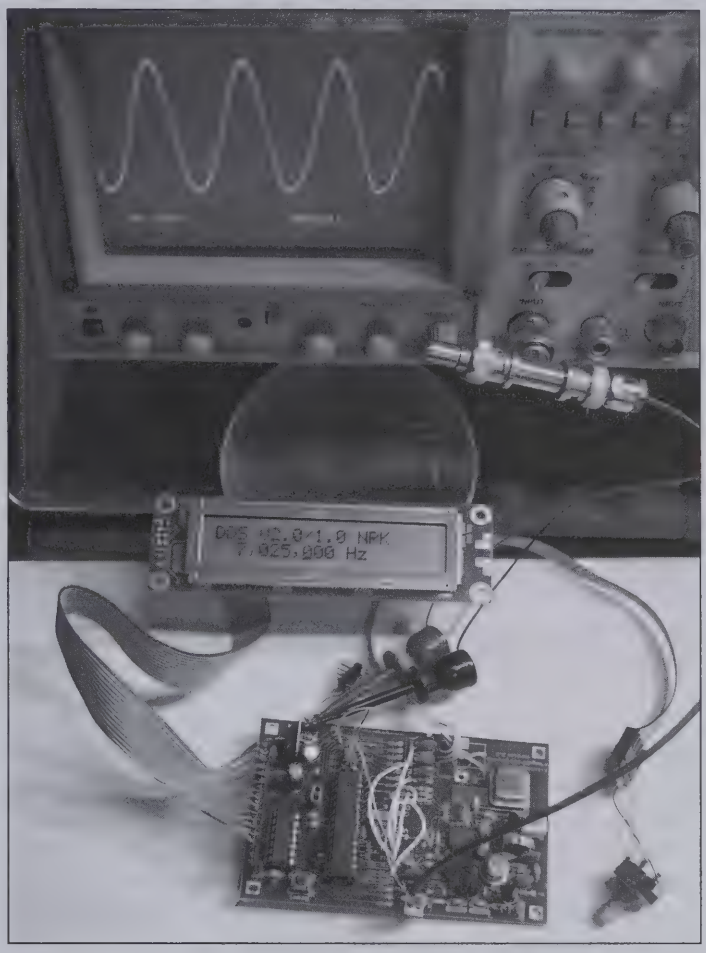
• A rotary encoder for controlling the frequency of the synthesizer. This could be the VFO knob of your homebrew rig. The encoder also has a push actuated switch which is programmed to change the frequency step.

• A 2N5109 amplifier boosts the output to about +17 dBm or ~40 milliwatts. Pads are provided for attenuators to bring the output down for typical diode mixers (+7 dBm) or active mixers (still lower).

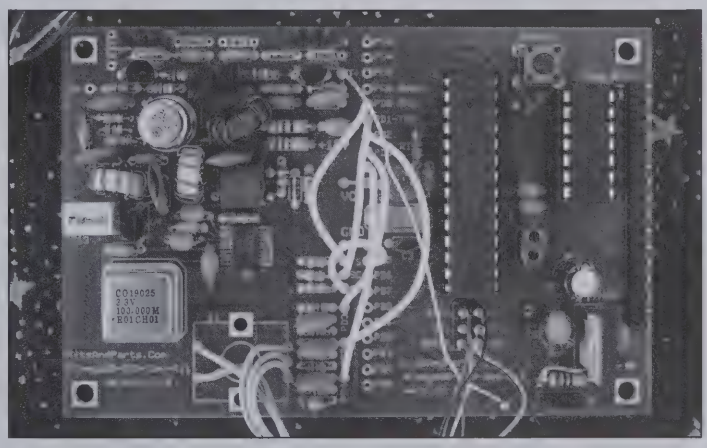
• PIN diode switches route the RF output to one of two output ports in a T/R switching fashion controlled by T and R logic lines.

• A shift register and connector header are provided to drive an LCD frequency readout which can be purchased separately and is already part of the firmware.

• For those who want to go their own way with the control software, the board includes a programming header for the MCU and Diz makes his source code available for user modification.



The DDS board in operation. The photo shows the encoder at lower right, plus the LCD display and 'scope trace of the RF output.

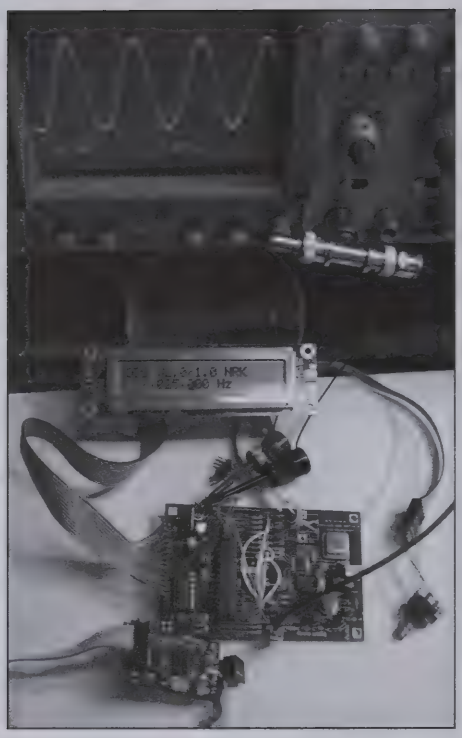


Close-up of the DDS board.

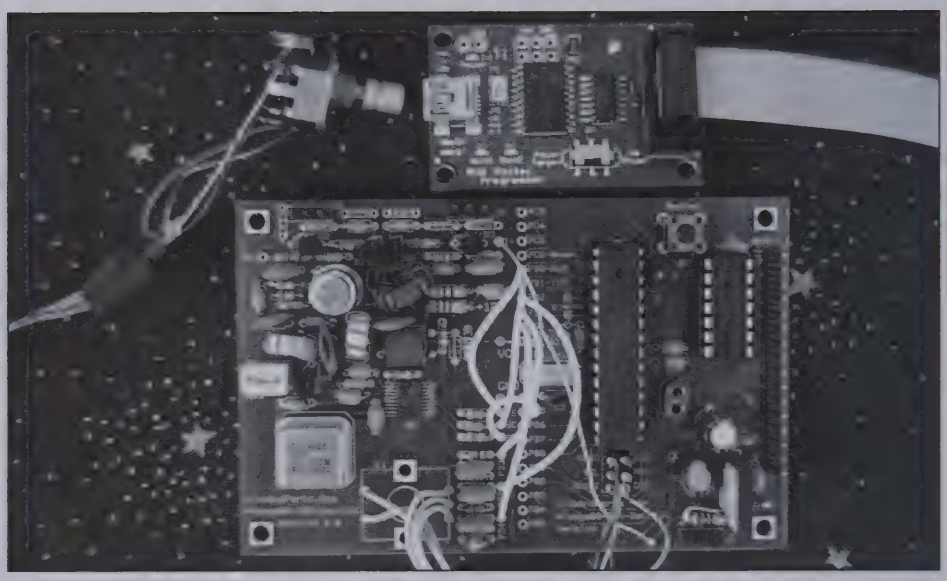
Building it

The kit is a straightforward build with a few options available. Everything is thru-hole and easily installed except the DDS chip itself, which is only available in the super tiny TSSOP package. Users can buy the kit with chip and install it, pay $5 to have it preinstalled, or use their own chip. I've installed some TSSOP stuff but it always makes me nervous when the time comes. This time I used some solder paste that was years past its shelf life and used the heat gun method (embossing tool from Hobby Lobby). I created many bridges, which I then cleared with solder wick and I was in business. There are three inductors and two transformers to wind. Nothing difficult although I built two boards and managed to mess up the connections on the 4:1 bifilar transformer on the second one. But that was easily corrected.

All of the parts fit well and locations are silk screened onto the board as an aid to installation. The programming header for the Atmel MCU may be a bit too close to the MCU itself such that there's interference when plugging in the programmer. This will only be an issue for those who want to change the programming



The DDS board and programmer board connected to the oscilloscope.



The DDS board with encoder and AVR Pocket Programmer board.

on the MCU, but it would be worthwhile to install a 6-pin header having longer pins so the connection is made above the level of the MCU chip, avoiding the interference.

The rotary encoder is intended to mount directly to the board, but I inserted a bit of ribbon cable between the two since I want to panel mount the encoder in a receiver I'm building. I used an LCD display I had on hand rather than one from Kits and Parts. The pin layouts are standardized enough among such units that this didn't require any wire position swapping in the ribbon cable. The board also provides for powering the back-lighting LED for displays having that feature.

Another thoughtful feature is that the three lines needed to control the DDS chip are made with jumpers between the DDS and MCU sides of the board, so you could redirect them to your PIC, Arduino, PicAxe or whatever, if you choose.

Using it

Apply 12 volts and it starts up on 10.000 MHz with an initial step size of 1 MHz so you can rapidly go to the desired frequency. Operation of the controls is smooth and predictable. An underscore below the appropriate display digit tells the current step size. Steps of 1 MHz to 1 Hz are available. If T/R switching is not needed, the user will want to jumper either the T or R line to 12 volts to direct the output to the desired port. I/O connections are all via 0.1" spaced pin headers.

Changing it

Is this kit a complete, stand-alone synthesizer or is it a "DDS development kit" as termed on the Kits and Parts website? It can be either or both, I guess. Many buyers will see a need or an opportunity in that programming header and the relatively untapped capability of the MCU chip. Like many in the competitive microcontroller industry, Atmel gives its large integrated development environment away for free. So one wishing to alter or replace the supplied program needs only to buy a programming interface. I selected the Pocket AVR Programmer from Sparkfun because I liked the price ($14.95) and use of the USB port.

The changes I've made to date involve adding bandswitching capability. Hold in the knob a little longer than for a step size change to enter a band menu, then rotate to select the band and press again to go there. I still need to add IF offset capability for my superhet receiver. If I add a transmitter, the DDS will operate on the transmit frequency, but for receive it will offset by 8 MHz. Note that the AD9834 chip has two sets of frequency registers, ideal for T/R use. Selection can be made by a software command or by changing the logic level on a pin. The pin isn't brought out on the board but I'm going to solder a #32 wire to it for the frequency toggle function.

The Forum

The Kits and Parts site includes a forum where users and builders share ideas and solutions. Several folks have done interesting things with the DDS board. Bruce, W8BH has added memories, keypad entry, and even a memory keyer to his board and published his changes as PDF papers which both act as tutorials and contain the source code. Anyone can read the forum posts. If you want to post, just choose an ID and password.

Conclusions

This kit offers a ready to use synthesizer with well considered and implemented features that can still be customized and extended by the user who wants to put a little of himself into a product.

Links and Reference

1. Kits and Parts website: http://www.kitsandparts.com/

2. Author's modified source code: http://pages.suddenlink.net/wa5bdu/dds_avr.txt

3. Readers can contact the author at kennnick@gmail.com ●●

Homebrew Keyer Paddles

Nico Vermeer—PA4NIC pa4nic@amsat.org

Editor's Note: Nico kindly submitted this great article to QRP Quarterly, *and we were immediately overwhelmed by the beauty of his photos. However, the article did require a bit of editing since Nico's primary language is Dutch. If any mistakes crept into the article, the fault is entirely mine. Nico is obviously a master of his craft. By all means, be sure to visit his website for more pictures—the black-and-white pages of* QQ *do not do them justice!*

Figure 1

Hi, I'm Nico, PA4NIC and I live in Haarlem, Netherlands. Haarlem is near Schiphol Airport, close to Amsterdam. I have been a ham since 1988 and Morse code is my favorite mode. Morse is more than just "beeps". You can do fun experiments, whether it is with QRP or perhaps a small antenna. You can hear small Morse signals much better than phone.

One day in the summer of 2009, I was in the garden enjoying the sun and wanting to build something. Of course, you can buy almost anything you want for amateur radio these days, but I enjoy making things myself. Then, I thought "I can make homebrew paddles with ball bearings and magnets!" And so began the story of the "Magnetic Twin Paddles."

My resources for making the paddles were somewhat limited. Figure 1 shows my small workshop in a barn where I sometimes make parts of the paddles. Because the workshop is so small, more often than not I find myself using a portable work table out in the garden. As you can see, almost all of the tools are hand tools. I do use a power drill and a router for working the edges of the wooden bases for my paddles.

You can see the materials involved in making the keys in Figure 2. Many of the parts can be salvaged from previous uses. For example, scraps of wood from other projects make the base. Old relay contacts can be used for key contacts, as can the contacts from an old battery charger. Small magnets are available from a variety of sources. Brass bolts are available from any hardware store and are easily solderable. I also use small quantities of lead for weighting the base of the paddles. A little heat allows molding the lead to a variety of shapes for different keys. To be sure, there is some detailed work to be done in mak-

Figure 2

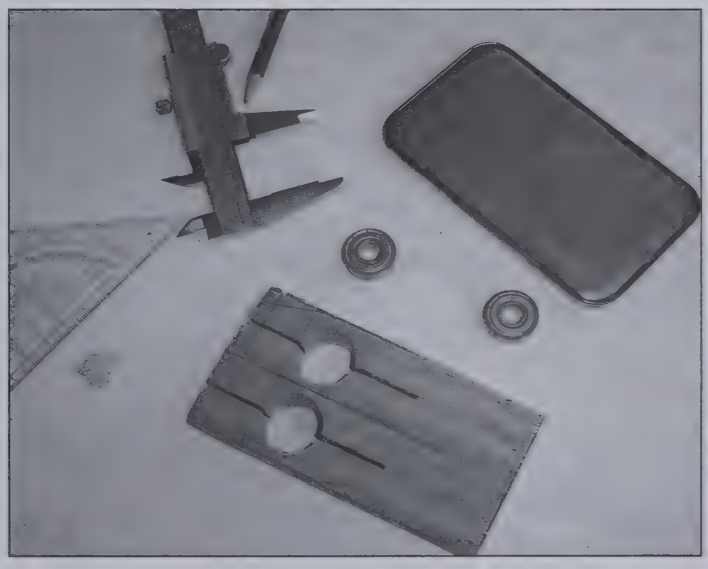


Figure 3

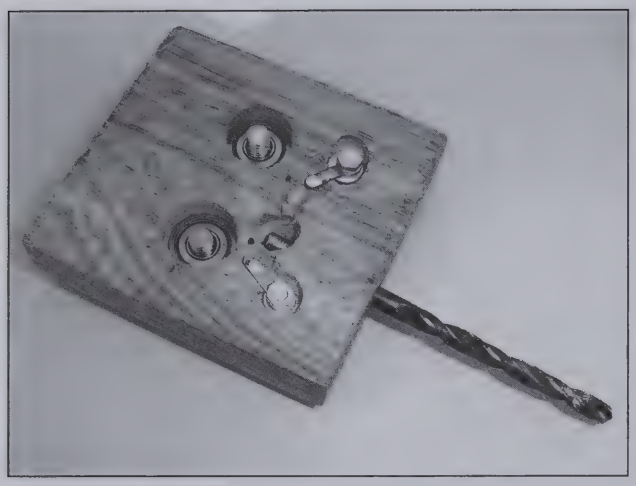


Figure 4

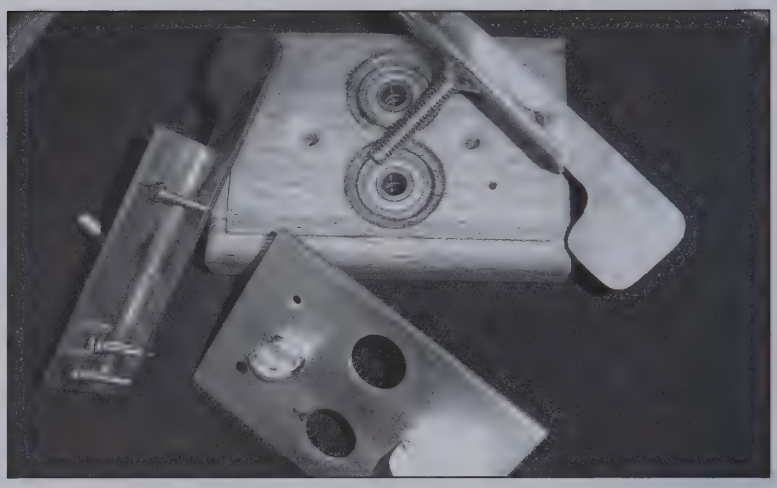


Figure 5

ing these paddles. But with some practice, the work can be accomplished with simple tools. I have been able to make several usable keys with these resources.

Making the Paddles

Now I will take you through the construction of a typical set of paddles to show you how I do it.

I begin by drawing a picture, and soon I have a model on paper. However, in practice things often begin to suddenly look very different during construction, hi hi. Figure 3 shows the first steps. You see a small block of wood near the bottom of the photo, two ball bearings near the center, and a container of lead which will provide some weight for the paddles.

I quickly found that the best way to protect the wiring needed for the paddles was to hollow out a portion of the underside of the base and run the wiring in that space. See Figure 4 for an example. The wires are placed in a channel which leads to a drilled hole where the wiring will exit the base. Later on, a weighted pedestal will be screwed to the underside of this base.

In Figure 5, you can see that the paddles are beginning to take shape. The ball bearings have been glued to the base and the paddles themselves have been constructed from printed circuit board material. The board material in the bottom center of the photo will be attached to the base to form contacts and a place to hold the magnets, which can be seen near the very bottom of the photo. The contacts are on either side of the smallest piece of vertical material and serve to ground the activated paddle. You will notice that each paddle looks slightly different as I do not use molds.

Figure 6 shows the paddles when finished. This is actually one of my later designs, and it works much better than my earlier paddles. The contacts are on the smaller vertical piece near the paddles. Distance between paddle contacts and ground can be set with the screws near the paddles. Further to the left, you can see the brass bolts that are used to set the travel distance of the contacts. Small pieces of insulating material are placed opposite the bolts to prevent ground contact. The ball bearings are mounted in the base between the contacts and the travel distance bolts. The bearings can't be seen because they are covered by board material. The whole piece stands on solid rubber feet.

Since my original paddle, I have made several more and am learning every day. Here I will show you several models I have made, with several of the keys operating quite differently. Most of them do use twin paddles made of printed circuit board, ball bearings and magnets to provide a return force.

Figure 7 shows some of my earlier paddles, and indicates that practice really does

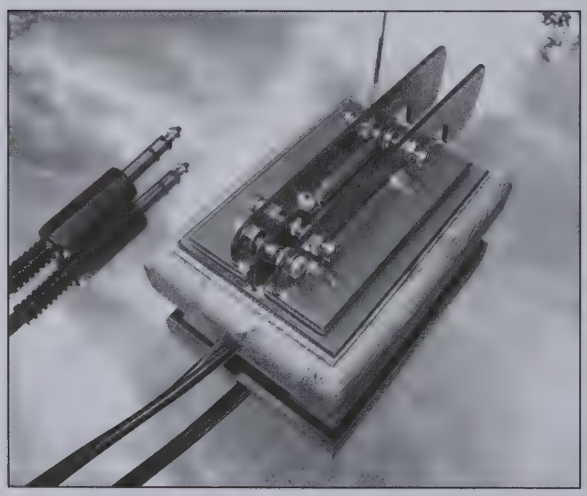


Figure 6

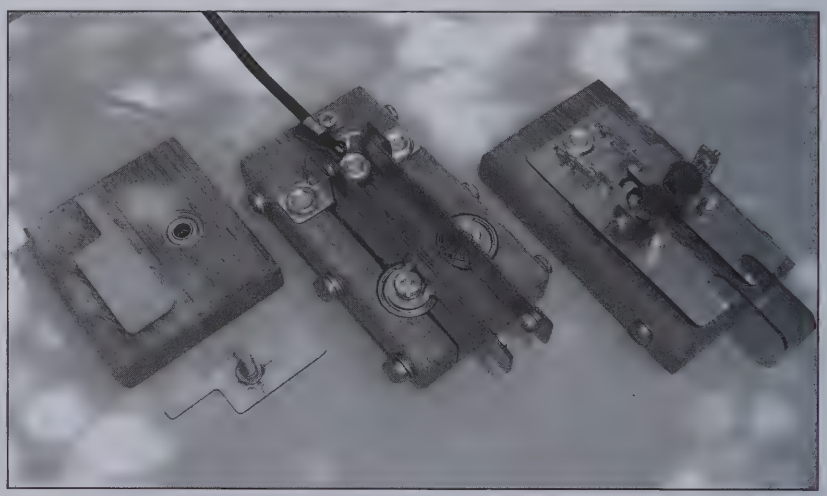


Figure 7

Figure 8

Figure 9

improve things. I have learned much about cutting, painting, picking the right wood, metal processing and other things with the making of each paddle. I have also learned how to improve the operation of my paddles. For instance, I have found that placing two inline ball bearings on each paddle removes the tendency of the paddle to skew sideways. In the end, these topics are crafts and learned by doing.

Figure 8 shows a paddle set that I constructed somewhat later than the paddles of Figure 7. It operates very nicely, but I am not satisfied with it in terms of appearance.

Figure 9 is my "Travel Paddle," which I use if I want to work portable. For this paddle, I placed the contacts between the tabs for the fingers. It may look a bit strange but it works very nicely.

Figure 10 is my last paddle set and so far my best. I use this to key my best radio, an IC-7800. I am very proud of it because it is not only beautiful but also very pleasant to use. The base is made of mahogany, a wood often used on boats. The handles are polished with steel wool and then a coat of transparent sealer is placed on the handles. I called it the IC-13, because it was my thirteenth set of paddles.

Figure 10

I thank you for looking at my homebrew paddles. Maybe they have encouraged you to try some of your own. If you want to see more, please visit my website, www.pa4nic.nl. The language on my site is Dutch, but the many photographs make things clear in any language. Here are some particular portions of the site you might like:

The paddles
www.pa4nic.nl/Homebrew%20paddle.html

Paddle details
www.pa4nic.nl/Paddle%20details.html

More homebrew
www.pa4nic.nl/foto%20eigenbouw.html

My radios
www.pa4nic.nl/foto%20apparatuur.html

...and for some related videos,
http://www.youtube.com/user/59nico

QRP Contests

Jeff Hetherington—VA3JFF

contest@qrparci.org

As you are reading this, I am sure you are also reflecting back on 2010 and your QRP Contesting experiences. Hopefully it is the good memories that you can recall, times of sunspot activity, and that rare state or DX station that popped up during the contest. For me, it is a time to look back, but also to look ahead to see what goals I would like to set for myself for the coming year. Looking at my logs, I see that I didn't get on the air as much as I would have liked, so with that in mind, my first personal goal is going to be to try to get more time in the seat during our events. My second goal for 2011 will be the same as it has been every year, and for every contest that I get a chance to sit down at the rig. Simply, I want to beat my personal best. On the wall beside my rig is a scrap of paper with my needed states for 5-band WAS, and I will add another scrap with all my personal bests listed so that I can compare my results with that goal as well.

There will be a few changes in the QRP-ARCI contests for 2011 as well. The first change that will be seen is that the Fireside Sprint SSB Contest dates have been changed. A few years ago the National Football League decided to move their championship date from the last Sunday in January, to the first Sunday in February. Great for the players, and a chance to build up some hype and excitement, but it completely interferes with our contest! As requested by all you football fans out there, we will move this contest in 2011 and going forward to the last Sunday in January and should coincide with the bye week for the football fans out there.

The second big change is that the Silent Key Memorial Sprint is being retired and replaced with a new contest suggested by a QRP-ARCI member and contest participant. On 27 August 2011 we will host our first Welcome to QRP sprint. This will be a Mentoring/Elmering contest experience. Each interested QRP-ARCI member will work alongside a newcomer to QRP, CW or QRP-ARCI. Invite them into your shack, visit them at their shack, or get outdoors and set-up a great QRP portable shack before the summer ends. The idea behind this contest is to promote QRP, CW and QRP-ARCI by using the guiding principle that "Each One Should Teach One." There will by many certificates available for both Elmer and Student based on performance, participation and QSO number milestones.

One final change that will affect all contests for 2011 is that the entry deadline has been reduced from one month after the contest, to two weeks after the contest. This will allow for the contests to be tabulated quicker, and the results finalized faster. At the same time, webmaster Steve, G4GXL, and myself are working on an online score submission tool to simplify the process for those that are on the internet. For those of your that do not log on the computer, or surf the web, don't worry, we will not be eliminating paper log submissions at this time.

This past quarter of contesting began back in May with our Hootowl Sprint. This contest is a challenging one as it is time shifted based on your local time to see how you can operate as the conditions change through the evening and approaching midnight. Tim Colbert, K3HX, showed that he was up to the challenge with 31,262 points and a first place showing. Just behind him was Paul Kirley, W8TM, with 23,408 points and Joe Vrabel, KD2JC, managed 18,060 points for a third place finish. Barry Ives, AI2T, with 15,680 points and Peter Mudgett, KN1PBA, with 8,281 points rounded out the top 5.

The milliWatt Field Day continues to be a fun and enjoyable QRP operating event across the country. This contest piggybacks on the ARRL Field Day and allows for some additional friendly competition between the various QRP groups and operators that always do so well in the overall ARRL results. The top score this year came from Bob Patten, N4BP, with 19,040 points in the 1E-Battery category. Second place was the Zuni Loop Mountain Expeditionary Force with 11,753 points running 5A. Dana A. "Mike" Michael, W3TS, came in third place with 7,042 points while John Watkins, NØEVH, scored 6,440 points and the Western New York QRP Society scored 3,990 points, both operating 1B-Battery for fourth and fifth place finishes respectively.

The Summer Homebrew Contest offered the chance to test out those projects and prove they are up to speed. Some chose to utilize homebrewed rigs, others melted the solder on the popular kits and a few even plugged in the modules of the K3. If you assembled it or built it, it is good for the bonus points that really drive the top scores in this contest. Bob Patten, N4BP, took his K3 to the top of the charts with 64,312 points to stay ahead of Tim Colbert, K3HX, and his K1 at 21,067 points. Nick Thomas, NT1A, and Dennis Bullock, N6DIT, both used KX1's for third and fourth place totals of 18,734 points and 17,583 points. Joe Vrabel rounded out the top five with 16,552 points from his K2.

The Silent Key Memorial Sprint weekend seemed to see several operators also take to the National/State/Provincial Parks for some portable operating. Personally I find it very relaxing sitting around the campsite and playing radio, and I'm seeing more participation from the members of QRP-ARCI that are doing the same thing. Bob Patten, N4BP, once again took top honours with 7,644 points although Barry Ives, AI2T, was right on his heels with 6,736 points. Joe Vrabel, KD2JC, outdistanced Robert MacKenzie, VA3RKM, for third place 5,560 points to 5,035 points. Randy Foltz, K7TQ, scored a total of 3,150 points for fifth place.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

2011 QRP-ARCI Contest Schedule

1 January 2011 — Pet Rock Sprint
30 January 2011 — Winter Fireside SSB Sprint
12 March 2011 — HF Grid Square Sprint

Mark Your Calendars!

2010 Hootowl Sprint Results

NAME	Call	S-P-C	Bands	POWER	Qs	Pts	SPC	Mult	Bonus	SCORE
Tim Colbert	K3HX	PA	ALL	< 5W	38	154	29	7	0	31262
Paul Kirley	W8TM	OH	40/80	< 5W	37	152	22	7	0	23408
Joe Vrabel	KD2JC	NJ	ALL	< 5W	30	129	20	7	0	18060
Barry Ives	AI2T	NY	ALL	< 5W	29	112	20	7	0	15680
Peter Mudgett	KN1PBA	MA	20/40	< 5W	20	91	13	7	0	8281
Dennis Bullock	N6DIT	CA	20/40	< 5W	11	37	9	7	5000	7331
Bill Cunningham	K4KSR	PA	40/80	< 5W		71	13	7	0	6461
Brian Forney	K7TKT	ID	20/40	< 5W	4	14	4	7	5000	5392
John T. Collins	KN1H	NH	ALL	< 5W	15	67	11	7	0	5159
Donald C. Younger	W2JEK	NJ	20/40	< 5W	13	53	11	7	0	4081
Mert Nellis	WØUFO	MN	20/40	< 5W	13	56	10	7	0	3920
Robert MacKenzie	VA3RKM	ON	20/40	< 5W	11	37	7	7	0	1813
Scott McMullen	W5ESE	TX	20/40	< 5W	8	31	8	7	0	1736
John Watkins	NØEVH	MO	20/40	< 5W	9	36	6	7	0	1512
Garry S. Nichols	WA1GWH	NY	80	< 5W	8	37	5	7	0	1295
Scott Yost	NM8R	MI	40	< 5W	7	35	5	7	0	1225
Jim Cluett	W1PID	NH	20/40	< 5W	7	34	5	7	0	1190
Rene Correa	K5JX	TX	20/40	< 5W	8	28	6	7	0	1176
Joe Spencer	KK5NA	TX	20	< 5W	5	25	5	7	0	875
Phill Bowers	KBØETU	AL	40	< 5W	5	25	5	7	0	875
Stan Reas	K4UK	VA	20/40	< 5W	5	19	5	7	0	665
Rick Arzadon	N8XI	MI	40	< 5W	4	17	4	7	0	476
Jim Huff	KD5KJ	AR	20/40	< 5W	3	15	3	7	0	315
Edwin E. "Ted" Albert	AB8FJ	OH	20/40	< 5W	2	10	2	7	0	140

Hootowl Sprint Soapbox

QRN on 80m. Activity seems less than in past years.—**K3HX**

40m was most productive but was noisy later. 20m gave some support later.—**KD2JC**

Propagation vastly improved over last year's Hoot Owl Sprint. Good turn-out too. Interesting to hear contest QSOs continuing after time was up on the east coast.—**AI2T**

The initial point is a single lone lava butte out in the middle of the desert with a 360 degree view for many miles in every direction. Pretty desolate. Great place for a transmitter since it is the highest spot for many miles. Strange place to be at midnight local time when odd people show up... Hada great time. I'm a fairly new ham and this was a fun event to plan for and participate in. Not as many contest QSOs as I'd have liked but had some very nice QRP ragchews while waiting for the contest to start. The band seemed to die about the strating time for the contest.—**K7TKT**

40m was kinda QRN noisy but had some fun on 20m. I should have spent more time on 40m during later hours but got lazy.—**WØUFO**

A pleasant cool-down after a busy WPX.—**VA3RKM**

Twenty was my best band as 40 was just trashed by T-storms parked 50 miles to my west. Lots of activity on 40 but mother nature won the night.—**NØEVH**

Last QRP was in 1974. 1st Hootowl contest. I'll be back. My wife (N8HGM) thinks the name is cute.—**NM8R**

he band was noisy with local storms in the area making for a lot of QRN. Had to keep the filters turned off and it was tough pulling out some of the signals. Also had some strong QRM—suspect it was coming through the power line—probably one of the neighbors running something. At 23 hours local time, the band just seemed to die. Guess when the east coast people shut down, the band went with them. It was fun and a challenge.—**KBØETU**

Didn't remember about the Sprint until I answered K4UPG CQ and asked him what club his #13489 was for - Hi! Hopefully I'll remember the Summer Homebrew Sprint.—**K4UK**

Not many stations heard. 40 meters was very noisy and very crowded.—**AB8FJ**

milliWatt Field Day Soapbox

Heavy QRM&QRN at this QTH. Sun did not coopearte this year.—**KA1PPV**

Bands very busy. Great fun! 100% solar power.—**K3HX**

Operating again from Lavpahoehoe Point Beach Park—Grid BK29jx—**KH6AA**

Op: NØEVH and KØWEW—**NØEVH**

Good food, good drink, kayaked, plenty of solar power, we even played a little radio.—**K2WNY**

Started looking for hunks of wire at 1100 local & did a 20-15m dipole by

Top 5 Hootowl Sprint

Tim Colbert—K3HX	31,262 pts
Paul Kirley—W8TM	23,408 pts
Joe Vrabel—KD2JC	18,060 pts
Barry Ives—AI2T	15,680 pts
Peter Mudgett —KN1PBA	8,281 pts

Category Winners—milliWatt Field Day

1A—J. Molon, KA1PPV	112 pts
1A-Battery—T. Colbert, K3HX	1,778 pts
1B—J-P. Couture, VA2SG	714 pts
1B-Battery—D. Michael, W3TS	7,042 pts
1D—E.E. "Ted: Albert, AB8FJ	287 pts
1E—A. Measday, WA5RML	392 pts
1E-Battery—B. Patten, N4BP	19,040 pts
2A-Battery—Ottawa Valley QRP	882 pts
3A-Battery—French Creek QRP	1,463 pts
5A—Zuni Loop, N6GA	11,753 pts

2010 milliWatt Field Day Results

NAME	Call	S-P-C	Bands	Power	Category	Qs	Pts	Mult	SCORE
Joseph Molon	KA1PPV	CT	40	< 5W	1A	8	16	7	112
Tim Colbert	K3HX	PA	20/40	< 5W	1A-Battery	127	254	7	1778
Hawaii QRP Club	KH6AA	HI	15	< 5W	1A-Battery	2	4	7	49
Jean-Pierre Couture	VA2SG	QC	20/40	< 5W	1B	51	102	7	714
Dana A. "Mike' Michael	W3TS	PA	ALL	< 5W	1B-Battery	503	1006	7	7042
John Watkins	NØEVH	MO	ALL	< 5W	1B-Battery	460	920	7	6440
WNY QRP Society	K2WNY	NY	ALL	< 5W	1B-Battery	304	570	7	3990
Ted Doty	AA5CK	OK	ALL	< 5W	1B-Battery	261	496	7	3472
Ade Weiss	WØRSP	AZ	ALL	< 5W	1B-Battery	129	258	7	1806
Larry Card	W9CC	IN	ALL	< 5W	1B-Battery	106	212	7	1484
Anthony Luscre	K8ZT	ME	ALL	< 5W	1B-Battery	99	175	7	1225
Dennis Bullock	N6DIT	CA	20/40	< 5W	1B-Battery	69	138	7	966
Jason Patterson	N3KCM	PA	ALL	< 5W	1B-Battery	80	88	7	616
Ron Hylton	AD7L	OR	40	< 5W	1B-Battery	39	78	7	546
Edwin E. "Ted" Albert	AB8FJ	OH	ALL	< 5W	1D	30	41	7	287
Andrew Measday	WA5RML	TX	15/20	< 5W	1E	28	56	7	392
Bob Patten	N4BP	FL	ALL	< 5w	1E-Battery	1360	2720	7	19040
Joe Vrabel	KD2JC	NJ	ALL	< 5W	1E-Battery	216	432	7	3024
Bill Cunningham	K4KSR	VA	ALL	< 5W	1E-Battery	201	402	7	2814
Donald McBride	K3RLL		ALL	< 5W	1E-Battery	60	120	7	840
Chuck Boblenz	AD6GI	CA	ALL	< 5W	1E-Battery	55	110	7	770
Ottawa Valley QRP Soc.	VA3OVQ	ON	ALL	< 5W	2A-Battery	74	126	7	882
French Creek QRP	W3PBC	PA	ALL	< 5W	3A-Battery	112	209	7	1463
Zuni Loop	N6GA	CA	ALL	< 5W	5A	958	1679	7	11753

splicing (perpendicular winding) 6 ft extensions on the ends of the 22 ft 15m but leaving the final 3/4 inch bare so I could swich bands by connecting the extensions or unsplicing them. No space for a 40m extension, so I just loaded the whole 20m vee fed thru 300 ohm ladder and balanced tuner. The Zin was astronomical and very high SWR loss even thru the ladder line. Buy hey, Wow! On 40m too. Hung it from the DK9SQ mast at 30 ft vee center. I had trouble keeping up with the pace at times!—**WØRSP**

Operated from Cadillac Mountain, Adadia National Park, Maine.—**K8ZT**

Operating time was limited this year, as I was attending functions for my 30th High School Reunion. Clearly no hams on the planning committee.—**AD7L**

First time to enter the Milliwatt Field Day. 15 meters was great on Saturday evening. Very easy to work stations using the Argonaut II at 5 watts and the random wire antenna.—**AB8FJ**

Didn't have much time available, but enjoyed what little I had. Concentrated on 15M to try to pick up some new states (got two!). See you next year - when I hope I can put in a real effort!—**WA5RML**

Fantastic condx, particularly on 10/15! My usual partner K4PG was on vacation, so single-op in this one for 23 hours. Easily my best score yet in QRP Field Day.—**N4BP**

Nice to work 2 contests at once. Thoroughly enjoyable.—**KD2JC**

Fun contest until battery failure. Learned to rely on new build batteries instead of pulls. DUH! Hope to cu agn.—**AD6GI**

We operated as 3AB as we operated the entire event using 12V batteries. The event was fun and we ate more than we operated—hi! Saturday night we sat around the campfire and ate marshmallows flambe—hi! We all stopped operating around 8pm each night and made a campfire. We then just sat there chatting and eating until we were stuffed, tired or wanted to operate some more. We had a great time and spent two nights in French Creek State Park, PA.—**W3PBC**

Silent Key Memorial Sprint Soapbox

Marginal condx and local thunderstorms. Gave up after about 45 minutes.—**N4BP**

Portable at the peak of Mount Pishgah, in Bradford County Pennsylvania, elevation 2360 feet, 1000 feet above average surrounding terrain. No hiking, just a steep climb in the Honda. Ice picnic area with tables and roof, monitored by a few turkey vultures. Not many stations on the bands. Strong signals from those that were. Had a good time.—**AI2T/3**

Camping at Lake George, New York.—**KD2JC**

Could not hear much activity on 20m and could not easily check other bands. Operated from the first Maplecon QRP gathering, camping near Peterborough, ON. We have can be grateful to those SK QRPers who were so active in building up this aspect of the hobby for us to enjoy today.—**VA3RKM**

20m was good, just not enough folks on. A good 1st hour followed by a not so good 2nd one. With over a 1/2 hour without a QSO, I gave up at the beginning of the 3rd hour. Thanks to those that came out.—**K7TQ**

A lot of fun, even though I was only on for a short time.—**K4JPN**

Local ham club had a meeting in the

Top 5 Silent Key Memorial Sprint

Bob Patten—N4BP	7,644 pts
Barry Ives—AI2T	6,736 pts
Joe Vrabel—KD2JC	5,560 pts
Robert MacKenzie—VA3RKM	5,035 pts
Randy Foltz—K7TQ	3,150 pts

2010 Silent Key Memorial Sprint Results

NAME	Call	S-P-C	Bands	Power	Qs	Pts	SPC	Mult	Bonus	SCORE
Bob Patten	N4BP	FL	20	< 5W	20	91	12	7	0	7644
Barry Ives	AI2T/3	PA	20/40	< 5W	8	31	8	7	5000	6736
Joe Vrabel	KD2JC	NJ	20/40	< 5W		20	4	7	5000	5560
Bob MacKenzie	VA3RKM	ON	20	< 5W	1	5	1	7	5000	5035
Randy Foltz	K7TQ	ID	20	< 5W	13	50	9	7	0	3150
Steve	K4JPN	GA	20	< 5W	8	40	8	7	0	2240
Jeremy Normal	GØAZR	England	20/80	< 1W	5	10	2	10	0	200
Scott McMullen	W5ESE	TX	20	< 5W	1	5	1	7	0	35
John Watkins	NØEVH	MO	20	< 5W	1	5	1	7	0	35

2010 Summer Homebrew Sprint Results

NAME	Call	S-P-C	Bands	Power	Qs	Pts	SPC	Mult	Bonus	SCORE
Bob Patten	N4BP	FL	ALL	< 5W	50	208	27	7	25000	64312
Tim Colbert	K3HX	PA	20/40	< 5W	24	93	17	7	10000	21067
Nick Thomas	NT1A	NH	20	< 5W	26	109	18	7	5000	18734
Dennis Bullock	W6DIT	CA	20/40	< 5W	10	41	9	7	15000	17583
Joe Vrabel	KD2JC	NJ	20/40	< 5W		72	13	7	10000	16552
Michael Bavoso	W6YDE	CA	20/40	< 5W	8	22	4	7	15000	15616
Jeff Hetherington	K6JSS/1	ME	20/40	< 5W	2	10	2	7	15000	15140
Carter Craigie	N3AO	VA	ALL	< 5W	14	58	11	7	10000	14466
R.C. Hulett	KB5JO	TX	20/40	< 5W	6	30	6	7	10000	11260
Jim Pole	KG2H	NY	20/40	< 5W	6	30	6	7	10000	11260
Robert MacKenzie	VA3RKM	ON	20/40	< 5W		27	6	7	10000	11134
Scott McMullen	W5ESE	TX	ALL	< 5W	6	27	6	7	10000	11134
Cameron Bailey	KT3A	OH	20	< 5W	6	30	5	7	10000	11050
Barry Ives	AI2T	NY	20	< 5W	3	15	3	7	10000	10315
Don DiTullio	N1LU	NH	20/40	< 5W	3	15	3	7	10000	10315
John T. Laney III	K4BAI	GA	20/40	< 5W	17	75	15	7	0	7875
Sean Kutzko	KX9X	CT	20/40	< 5W	8	31	8	7	5000	6736
Larry Card	W9CC	IN	20	< 5W	3	15	3	7	5000	5315
Edwin E. "Ted" Albert	AB8FJ	OH	20	< 5W	2	10	2	7	5000	5140
Will Bowser	K9FO	IL	20	< 5W		54	9	7	0	3402

morning, so only made it for the last 20 minutes.—**W5ESE**

Summer Homebrew Sprint Soapbox

Poor conditions at the start on 20m, entire sprint too early for 40m in SFL. Single band except for W4OV who ran 5 bands with me.—**N4BP**

QRN from storms, much QSB. - K3HX KX1 just built in the past 2 days worked great. Condx were decent and so was the wx. I had a great time!—**NT1A**

Fast 4 hours. Beauty day, lucky too 7-11.—**N6DIT**

Wish condx were better here. 40m and 20m was all I could work. It'll be interesting to see how others did.—**KD2JC**

Activated the club callsign from Lobstercon.—**K6JSS/1** (VA3JFF op.)

Operated from back patio using 7AH Gel Cell. Got up to 91F on the patio.—**KB5JO**

Not many participants, took time off.—**KG2H**

Conditions were not great for the earlier IARU Contest, nor for ours.—**VA3RKM**

Enjoyed using the AT Sprint 3 in the Homebrew Sprint. Tried my MFJ Cub 9315K on 15, but the band seemed dead.—**W5ESE**

Worked portable from the hotel parking lot.—**KT3A**

Portable from Newton Battlefield State Park. Conditions seemed very poor. Heard a few stations after first half hour, but too weak to make QSOs.—**AI2T**

Top 5 Summer Homebrew Sprint

Bob Patten—N4BP	64,312 pts
Tim Colbert—K3HX	21,067 pts
Nick Thomas—NT1A	18,734 pts
Dennis Bullock—N6DIT	17,583 pts
Joe Vrabel—KD2JC	16,552 pts

Poor conditions. Thought my KX-1 was bad. Checked condx on my QRO rig and regular antenna and not much better. We could use those sunspots anytime now!—**N1LU**

My first ARCI contest since joining! Operated only 2 hours with my simple setup at a park near my apartment. I threw a 50ft random wire in a tree at a 45-degree angle from the back of my balun, ran a 20ft counterpoise on the ground, and called CQ. I had a lot of fun and enjoyed working some DX too. I'll be back for more!—**KX9X**

I operated battery power with a temporary doublet antenna.—**W9CC**

Only had about 30 minutes to operate this time. Only heard 2 stations on 20m, and was able to work them both.—**AB8FJ**

Homebrew not set up, so no bonus. Poor conditions.—**K9FO** ●●

Contest Announcements

FOR ALL CONTESTS:

Email Log Submission:
Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to va3jff@yahoo.ca

Snail mail Log Submission:
Submit Logs along with a summary stating your Callsign, Entry Categorym Actual Power and Station Description along with score calculation to:

(Contest Name)
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website. Certificates will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2011 QRP-ARCI Pet Rock Celebration

Date/Time:
1500Z to 1800Z on Saturday 1 January 2011.

Mode:
HF CW only.

Exchange:
Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 Watts = x1
>1 - 5 Watts = x7
>500 mW - 1 Watt = x10
>200 mW - 500 mW = x15
>55 mW - 200 mW = x20
<55 mW = x25

Suggested Frequencies:
Please remember this is a contest is focusing on rock-bound transmitters/transceivers.

80m	3560 kHz
	3568 kHz
40m	7030 kHz
	7040 kHz
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Bonus Points:
For crystal controlled gear add 2,000 points for using rockbound receiver; add 3,000 points for using rockbound transmitter; or add 5,000 points for using rockbound transceiver. These bonus points are available per band.

If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Score:
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Categories:
Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

How to Participate:
Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:
Entries must be postmarked on or before 15 January 2011.

2011 QRP-ARCI Fireside SSB Sprint

Date/Time:
2000Z to 2359Z on 30 January 2011

Mode:
HF SSB only.

Exchange:
Members send: RS, State/Province/Country, ARCI member number
Non-Members send: RS, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>10 Watts = x1
>2 - 10 Watts = x7
>500mW - 2 Watts = x10
>100mW - 500mW = x15
100mW or less = x20

Suggested Frequencies:

80m	3985 kHz
40m	7285 kHz
20m	14285 kHz
15m	21385 kHz
10m	28385 kHz

Bonus Points:
If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations

with 5 element yagis at 70 ft.

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:

Entries must be postmarked on or before 13 February 2011.

2011 QRP-ARCI HF Grid Square Sprint

Date/Time:

1500Z to 1800Z on 12 March 2011.

Mode:

HF CW only.

Exchange:

Members send: RST, 4 Digit Maidenhead Grid Square (i.e. FN02), ARCI member number

Non-Members send: RST, 4 Digit Maidenhead Grid Square (i.e. FN02), Power Out

QSO Points:

Member = 5 points

Non-Member, Different Continent = 4 points

Non-Member, Same Continent = 2 points

Multiplier:

Grid Square total for all bands. The same station may be worked on multiple bands for QSO points and Grid Square credit.

Power Multiplier:

>5 Watts = x1

>1 - 5 Watts = x7

>250 mW - 1 Watt = x10

>55 mW - 250 mW = x15

55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound QRPers)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Bonus Points:

If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Score:

Final Score = Points (total for all bands) x Grid Squares (total for all bands) x Power Multiplier + Bonus Points.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

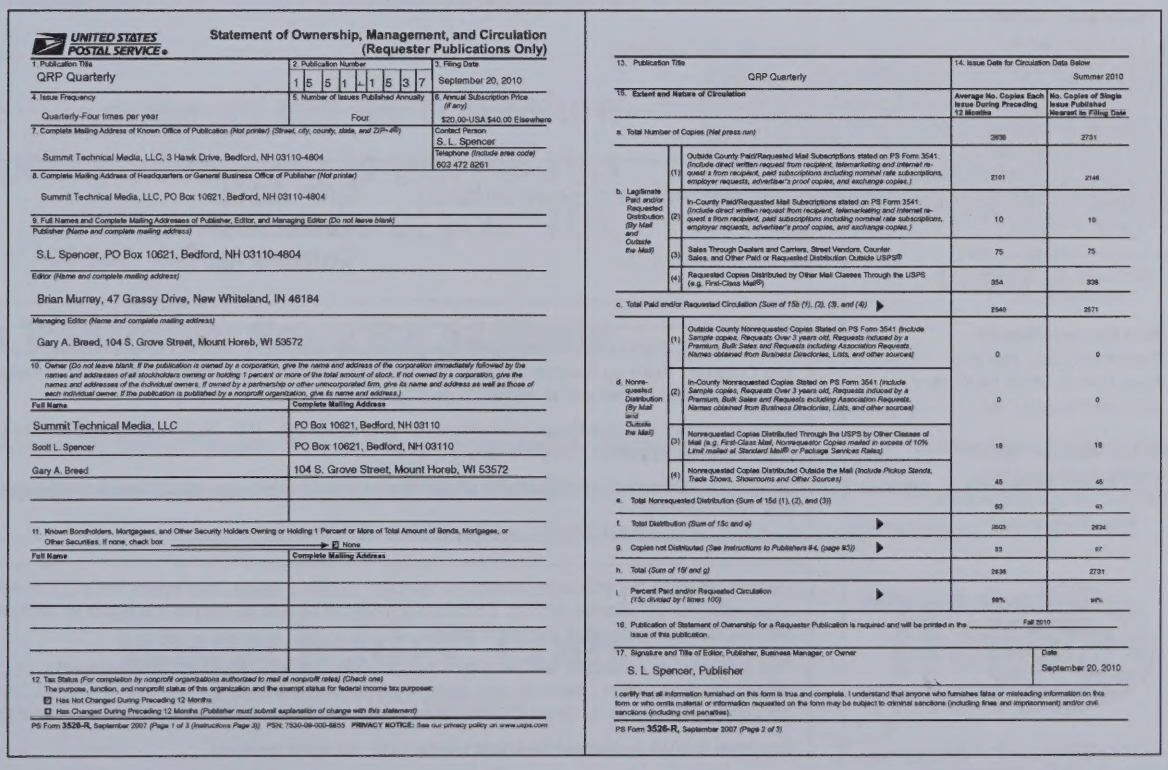
How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:

Entries must be postmarked on or before 26 March 2011.

●●



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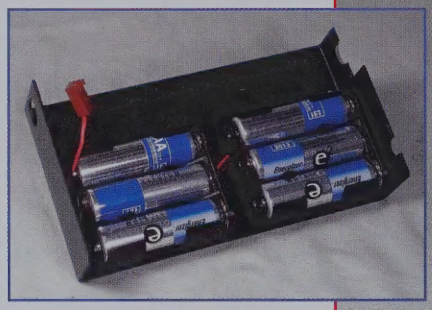
- Internal ATU
- Internal battery



Our KX1 CW transceiver kit is the ultimate portable rig. With all controls on top, it's ideal for trail-side, beach chair, sleeping bag, or picnic table operation. And at 1.3"H x 5.3"W x 3"D, it's truly pocket size. Its superhet receiver covers ham and nearby SWL bands; the variable-bandwidth crystal filter handles CW, SSB, and AM. Also features memory keyer, RIT, 3-digit display, audible CW frequency readout, and a white-LED logbook lamp. The internal battery provides *20 to 30 hours* of casual operation. Add our KXPD1 paddle and KXAT1 automatic ant. tuner options to create a fully-integrated station. Basic kit covers 20 & 40 m ($299). KXB3080 adds 30 & 80 m ($79).

K1 and K2 Transceivers

The compact K1 4-band, 5 watt+ CW transceiver kit is great for first-time builders, draws only 55 mA on receive, and makes a great travel radio. The K2 transceiver kit offers excellent receiver performance, all-band SSB/CW coverage and optional DSP. It can be configured for 100 watts when the going gets rough. Both transceivers have internal battery and automatic antenna tuner options. Visit our web site for details on our other kits, including the all-mode, all-band K3.

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